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PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

JANUARY 1951

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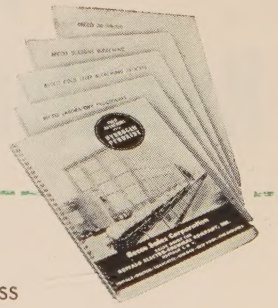

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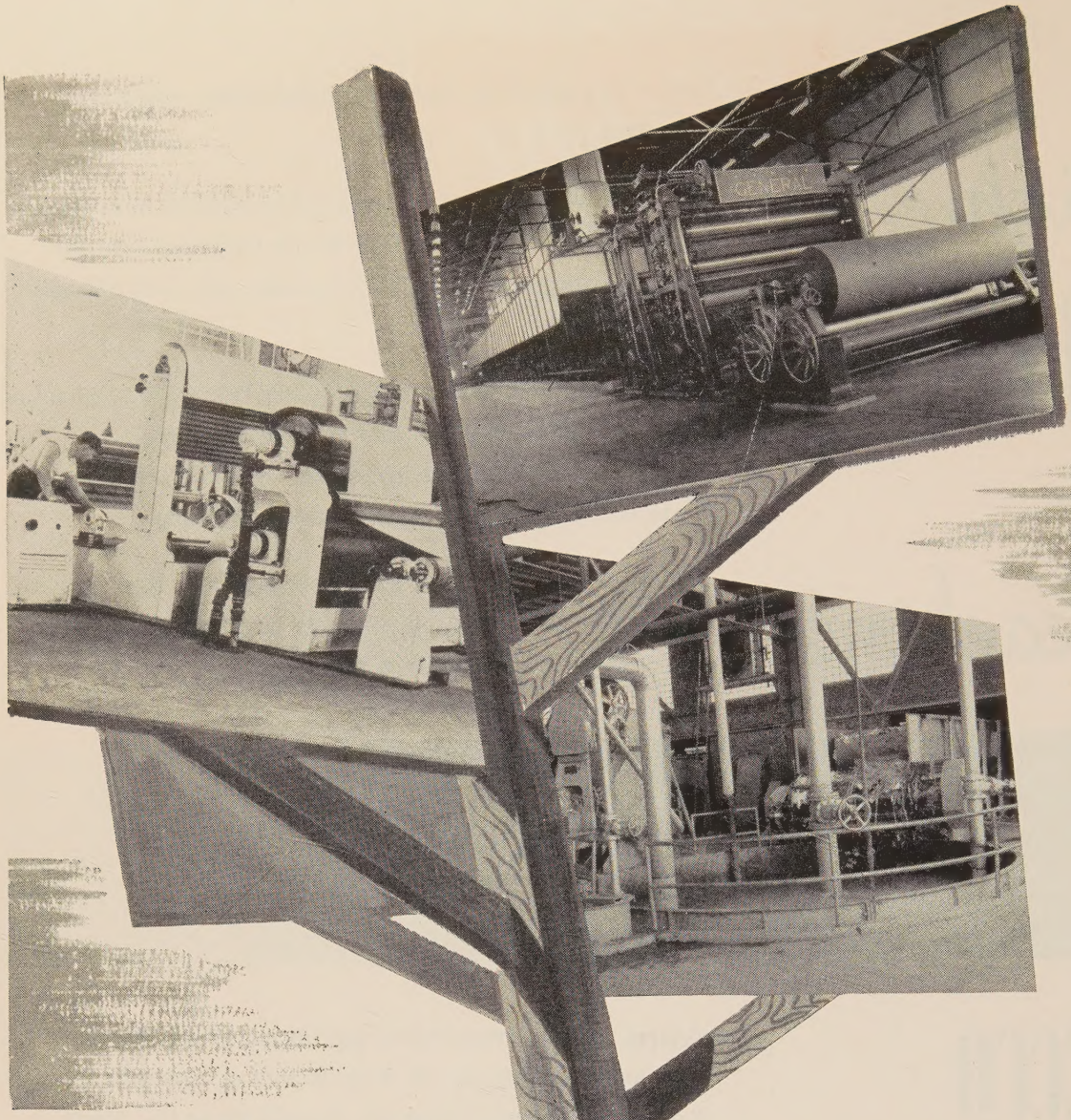

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JANUARY 1951

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TECHNICAL ARTICLES

Abatement of Sulphate Pulp Mill Odor and Effluent Nuisances, *by W. O. Hisey* 1
Hydrogenation of Douglas-Fir Lignin, *by Ira T. Clark, James R. Hicks, and Elwin E. Harris* 6
Application of Hydrogen Sulphide in Sulphidity Control, *by L. B. Taylor* 12
Presence of Galactose Units in Unbleached Kraft Pulps, *by Louis E. Wise, Ruth C. Rittenhouse, and Consuelo Garcia* 15
Factors Influencing the Service Life of Brick Linings in Sulphite Digesters, *by Beaumont Thomas* 16
Effect of Storage of Southern Pine on Pulp Yield and Quality, *by H. L. Keaton and W. F. Gillespie* 21
Control of Condensate Return Line Corrosion, *by William A. Tanzola* 25
The Effect of Certain Latex Variables in Beater Addition of Nitrile Rubber Latices, *by D. M. Yost and W. H. Aiken* 30
Effect of Certain Papermaking Variables upon Beater Addition of Nitrile Rubber Latices, *by D. M. Yost and W. H. Aiken* ... 40

DEPARTMENTS

TAPPI Annual Meeting Program ..... 10 A
TAPPI Nonfibrous Raw Materials Report—1950, *by E. N. Poor* 22 A
Association News and Events ..... 45 A
Personal Mention ..... 46 A
Obituaries ..... 56 A
Tappi Divisions and Committees ..... 58 A
Reports and Discussions ..... 69 A
Recent Books ..... 71 A
Slime Acclimatization, *by Paul A. Sartoretto* ..... 72 A
Stream Improvement—Settling Pulp and Paper Mill Waste Waters and Dewatering Bulk Solids, *by August S. Erspamer and William D. Rice* ..... 73 A
Silicate of Soda Uses in the Paper Mill, *by F. Robert MacGonagle* 77 A
Local Section Activities ..... 79 A
The ABC's of Gravure, *by Frank B. Johnson* ..... 82 A
Employment Service ..... 90 A
Calendar of TAPPI Meetings ..... 91 A

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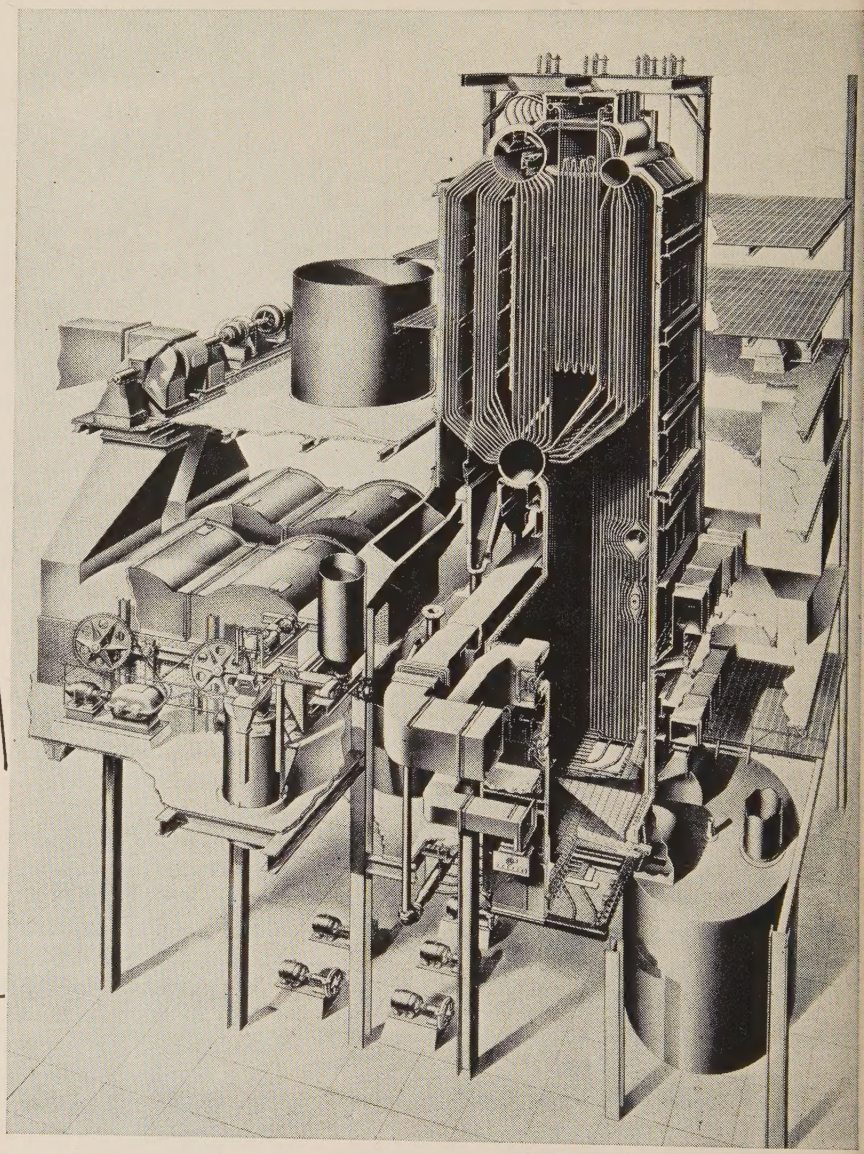

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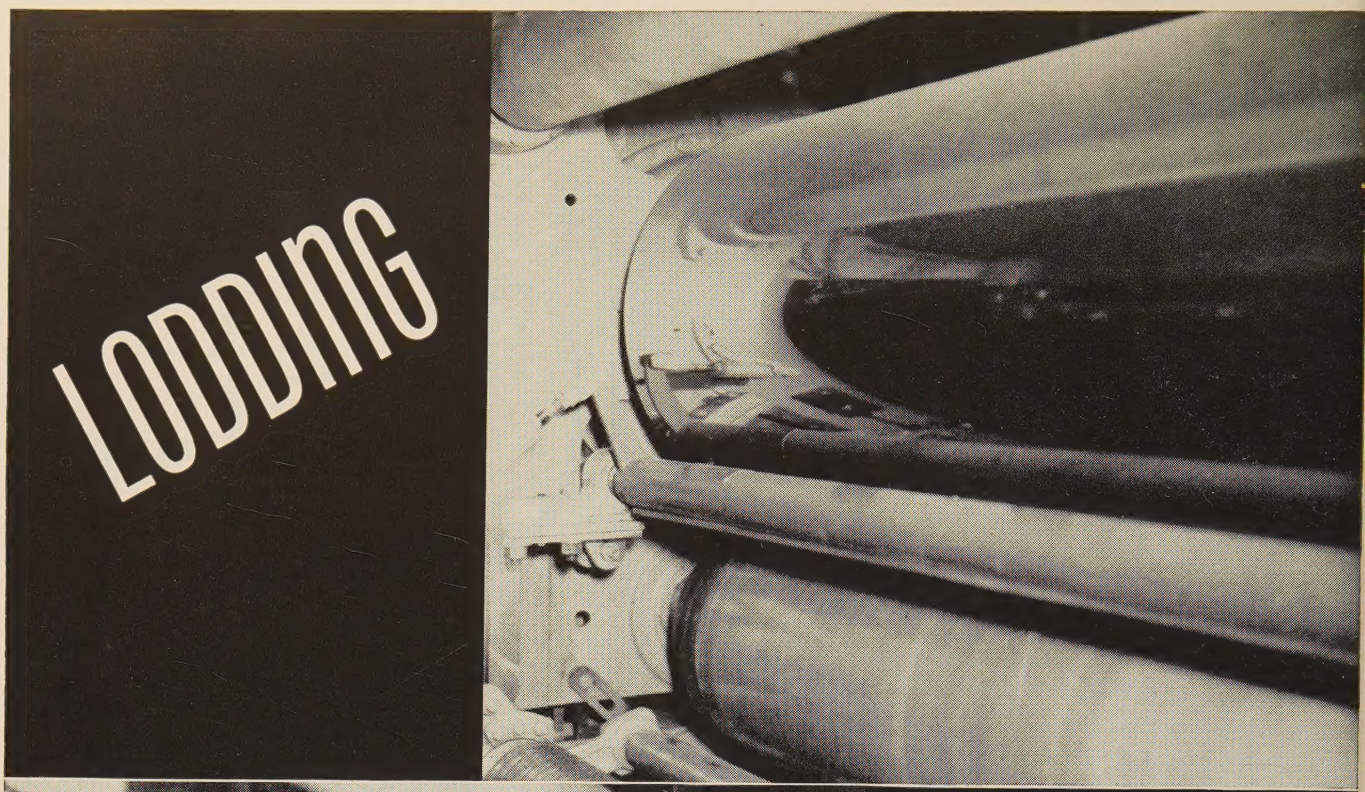

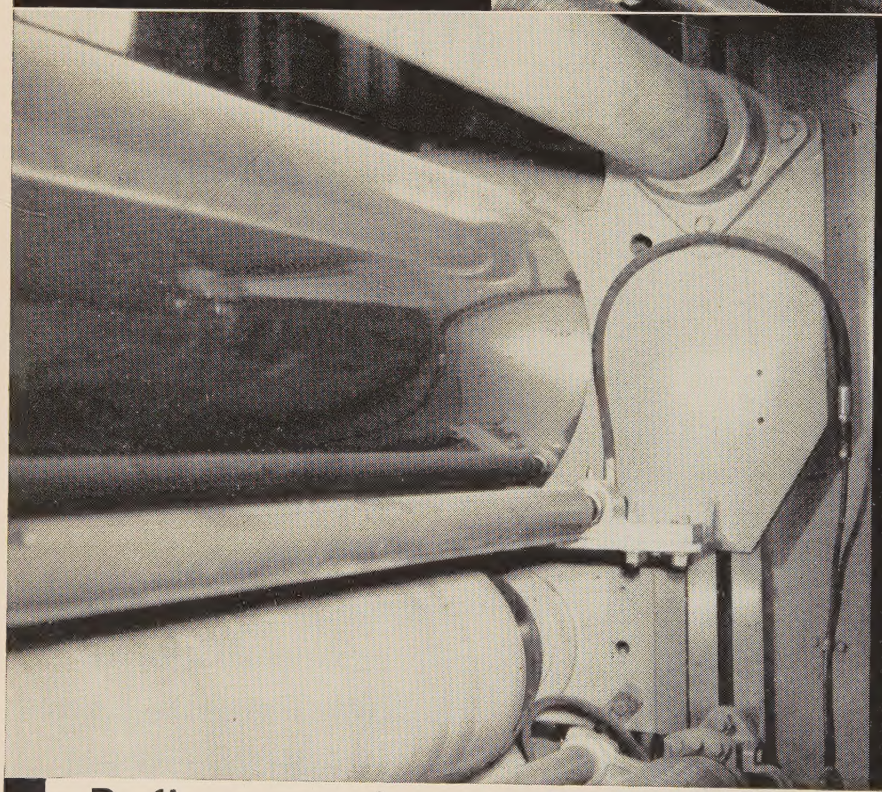

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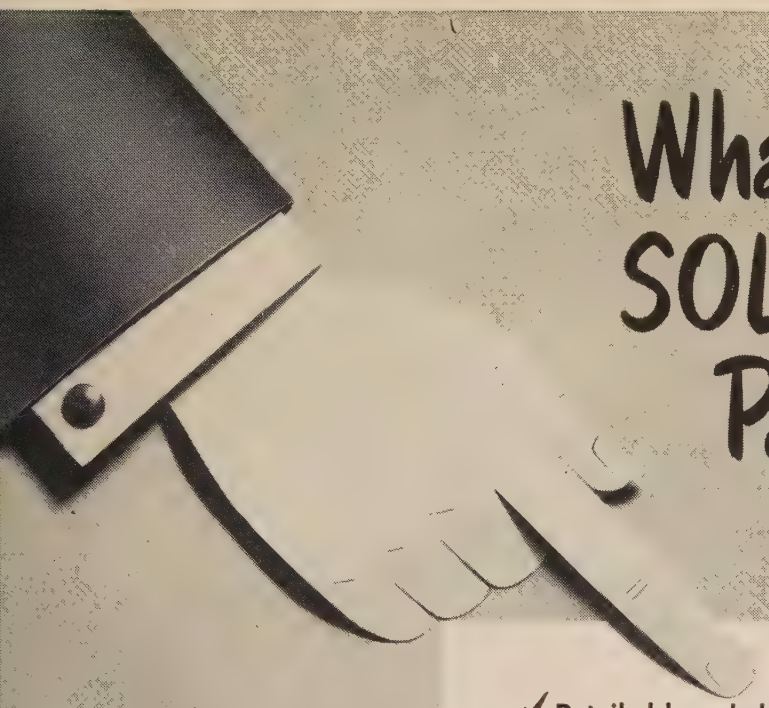

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TAPPI Annual Meeting Program

Commodore Hotel, New York, N. Y., February 19-22, 1951

MONDAY, FEBRUARY 19, 1951

10:00 a.m. First General Session (East Ball Room)

A. E. Bachmann, President of TAPPI, Missisquoi Corp., Cheldon Springs, Vt., *Chairman*

1. Secretary's Report, by R. G. Macdonald.
2. President's Address, by A. E. Bachmann.
3. Report of Tellers Committee.
4. Report of Joint Text Book Committee, by J. N. Stephenson.
5. "Chemical Engineering Unit Operations in the Pulp and Paper Industry," by W. L. Badger, Consulting Chemical Engineer, Ann Arbor, Mich.

2:00 p.m. Committee Meetings (Grand Ball Room)

All committee meetings will be held in the Grand Ball Room unless otherwise indicated. Any member of the Association may attend any committee meeting. If you are not at present a member of a committee please introduce yourself to the Chairman of the committee that interests you and in whose work you would like to participate.

Research Development Division (Grand Ball Room)

Fundamental Research Committee—H. F. Lewis, *Chairman*
Statistics Committee—T. A. Pascoe, *Chairman*
Microbiological Committee—R. F. De Long, *Chairman*
Patents Committee—Frank Makara, *Chairman*

Industrial Division (Grand Ball Room)

Vocational Education Committee—B. E. Lauer, *Chairman*
Nonfibrous Raw Materials Committee—E. N. Poor, *Chairman*
Water Committee—A. S. Erspamer, *Chairman*
Fibrous Agricultural Residues Committee—S. I. Aronovsky, *Chairman*
Structural Fibrous Raw Materials Testing Subcommittee—E. M. Jenkins, *Chairman*
Structural Fibrous Finished Products Testing Subcommittee—Emile Frederick, Jr., *Chairman*

Converting and Consuming Division (Room B-C)

Containers Committee—H. T. Barker, *Chairman*
Graphic Arts Committee—F. D. Elliott, *Chairman*
Coating Committee—J. H. Heuer, *Chairman*
Wet Strength Committee—K. W. Britt, *Chairman*
Resin Analysis Subcommittee—W. A. Schenk, *Chairman*
Cellulosic Materials Subcommittee—F. A. Simmonds, *Chairman*
Plastics in Paper Converting Subcommittee—R. T. Nazzaro, *Chairman*
Fabrication and Structural Products Subcommittee—C. J. Straka, *Chairman*
Plastics Committee (3:30 p.m.)—E. C. Jahn, *Chairman*

Pulp Manufacture Division (Grand Ball Room)

Alkaline Pulping Committee—Henry Vranian, *Chairman*
Mechanical Pulping Committee—F. W. O'Neil, *Chairman*
Chemical Products Committee—A. Pollak, *Chairman*
Pulp Purification Committee—W. D. Harrison, *Chairman*

Paper Manufacture Division (Grand Ball Room)

Preparation of Papermaking Materials Committee—J. J. Thomas, *Chairman*
Papermaking (Cylinder) Committee—J. J. Harrison, *Chairman* (Room E)
Papermaking (Fourdrinier) Committee—N. R. Phillips, *Chairman*

Testing Division (West Ball Room)

Nonfibrous Materials Testing—J. P. Casey, *Chairman*
TAPPI-ASTM Joint Committee on Petroleum Wax—A. M. Heald, *Chairman*
Pulp Testing Committee—L. V. Forman, *Chairman*
Optical Properties Committee—A. H. Croup, *Chairman*
Microscopy Committee—C. E. Brandon, *Chairman*
Paper Testing Committee—A. K. Warner, *Chairman*
Packaging Materials Testing Committee—L. E. Simerl, *Chairman*
Chemical Methods Committee—A. S. O'Brien, *Chairman*
Container Testing—W. J. Balster, *Chairman* (Room F)

Engineering Division (Room A)

Steam and Power Committee—C. J. Sibler, *Chairman*
Materials Handling Committee—A. P. Schnyder, *Chairman*
Drying and Ventilating Committee—M. L. Barker, *Chairman*
Engineering Research and Machine Design Committee—J. D. Lyall, *Chairman* (Also luncheon meeting 12:30 p.m. Room E)
Mill Design and Economic Aspects Committee—R. A. Packard, *Chairman*
Hydraulics Committee—K. J. Mackenzie, *Chairman*
Mill Maintenance and Materials Committee—H. F. Parker, *Chairman*
Electrical Engineering Committee—A. S. Goodrich, *Chairman*
Chemical Engineering Committee—J. R. Lientz, *Chairman*
Data Sheets Committee—H. J. Perry, *Chairman*

TUESDAY, FEBRUARY 20, 1951

9:15 a.m. Water (Grand Ball Room)

A. S. Erspamer, P. H. Glatfelter Co., Spring Grove, Pa., *Chairman*

Symposium on White Water and Waste Treatment

1. "Waste Water Disposal Program at Scott Paper Co.," by David R. Wadleigh, Scott Paper Co., Chester, Pa., and L. G. Simons, Chas. T. Main, Inc., Boston, Mass.
2. "The Bird-Gibbs Flotation Saveall," by Sven Fahlgren, Bird Machine Co., So. Walpole, Mass.
3. "Pennsylvania Standards for Water," by J. R. Hoffert, Chief Engineer, Commonwealth of Pennsylvania, Dept. of Health, Sanitary Water Board, Harrisburg, Pa.
4. "Experimental Chemical Treatments for Kraft Mill Waste," by William Moggio, National Council for Stream Improvement, New York, N. Y.
5. "Correlation of B.O.D. and Chemical Tests on Industrial Effluents," by K. G. Chesley, R. W. White, and R. V. Hogg, Jr., Crossett Paper Mills, Crossett, Ark.

9:15 a.m. Structural Fibrous Materials (Room B-C)

John F. Campbell, Flintkote Co., Meridian, Miss., *Chairman*

1. "Light Reflection Measurements as Related to Decorative Insulation and Acoustical Products," by Richard S. Hunter, Henry A. Gardner Laboratory, Bethesda, Md.
2. " Preservation of Insulating Wallboard Against Decay and Insect Attack," by E. A. Behr, A. D. Chapman Co., Memphis, Tenn.
3. "Insulation Board Products and Their Relation to Various Building Codes," by Charles Gray, Insulation Board Institute, Chicago, Ill.
4. "Trends in the Insulation Board Industry," by J. O. Burton, Minnesota & Ontario Paper Co., International Falls, Minn.
5. "Flame-Resistant Surface Insulation Board and Methods of Test," by J. J. Perot, Whippany, N. J.

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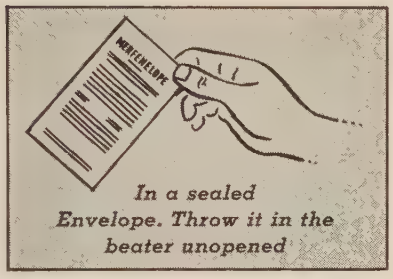

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6. "Report on Insulation Board Institute Technical Committee Activities and Problems," by E. M. Jenkins, Johns-Manville Corp., Manville, N. J.
7. "Report on Progress of Finished Products Testing Subcommittee and Future Program," by Emile Frederick, Jr., Celotex Corp., Marrero, La.
8. "Report on Progress of Raw Materials Testing Subcommittee and Future Program," by E. M. Jenkins, Johns-Manville Corp., Manville, N. J.
9. Discussion of Freeness Testing and Test Board Formation, by a member of the Raw Materials Testing Subcommittee.
10. Business Meeting and Discussion of Committee Program for the Current Year.

9:15 a.m. Plastics (West Ball Room)

E. C. Jahn, New York State College of Forestry, Syracuse, N. Y., *Chairman*

1. "Configuration and Structure of Cellulose Xanthate," by C. Y. Chen, Ralph E. Montonna, and C. S. Grove, Jr., Syracuse University, Syracuse, N. Y.
2. "The Bonding Strength of Certain Adhesives on Liner Board," by Geoffrey Broughton and Ernest R. Kaswell, Fabric Research Laboratories, Boston, Mass.
3. "The Use of Redwood Plastic Pulps in Paper-Base Laminates," by T. A. Howells, Institute of Paper Chemistry, Appleton, Wis.
4. "Latex Coating," by Elmer K. Stilbert, Dow Chemical Co., Midland, Mich.

9:15 a.m. Alkaline Pulping (East Ball Room)

Henry Vranian, Chesapeake Corp. of Virginia, West Point, Va., *Chairman*

1. "Recausticizing in the Southeast," (Including Some Practical Operating Suggestions) by Irwin W. Johnston, The Dorr Co., Atlanta, Ga.
2. "The Properties of High Yield Kraft Pulps Produced at Bathurst," by J. McK. Limerick, Bathurst Power and Paper Co., Ltd., Bathurst, N. B.
3. "Rate of Beating of Pre-Refined Kraft Pulps," by H. Wyatt Johnston, Sutherland Refiner Corp., Montreal, P. Q., and W. C. Lodge, Pulp and Paper Research Institute of Canada, Montreal, P. Q.
4. "Further Studies on the Alkaline Pulping of Scrub-Oak," by William J. Nolan, University of Florida, Gainesville, Fla.
5. "Redwood as a Potential Source of Pulp," by Harry F. Lewis, Institute of Paper Chemistry, Appleton, Wis.
6. "Some Factors Influencing Color Reversion in Bleached Secondary Fiber," by J. J. Forsyth, International Paper Co., Niagara Falls, N. Y.
7. "Odor Elimination in a Sulphate Pulp Mill," by P. Ghisoni, G. Bozza, and P. Colombo, Vita Mayer & Co., Milano, Italy (By title).

9:15 a.m. Paper Making (Fourdrinier) (Room A)

Noel R. Phillips, Champion Paper and Fibre Co., Canton, N. C., *Chairman*

Round-Table Discussion of "Paper Defects—Cause and Cure." (Attendance by Invitation.)

2:00 p.m. Corrugated Containers (West Ball Room)

F. D. Long, Container Corp. of America, Chicago, Ill., *Chairman*

Panel Session on "Manufacture, Inspection and Testing of Weatherproof Corrugated Board."

1. "New Developments in Starch Adhesives," by J. E. Killinger, Penick & Ford, Ltd., Inc., Cedar Rapids, Iowa, Moderator of Panel.
2. "Starch Urea Adhesives," by E. S. Gantt, Corn Products Refining Co., Argo, Ill.
3. "PVA Adhesives," by E. G. Boyce, Grasselli Div., E. I. du Pont de Nemours & Co., Inc., Cleveland, Ohio.
4. "Silicate Adhesives," by Robert Kreyling, Philadelphia Quartz Co., Philadelphia, Pa.
5. "Commercial Testing," by C. J. Zusi, Container Laboratories, Inc., Chicago, Ill.
6. "Quartermaster Inspection and Tests," by Capt. R. E. Willits, Philadelphia Quartermaster Depot, U. S. Army, Philadelphia, Pa.
7. "Production of Corrugated Board," by J. J. Koenig, Gaylord Container Corp., St. Louis, Mo.
8. "Study of Containers Used in Export," by M. Young, Maritime Association of the Port of New York, New York, N. Y.

2:00 p.m. Vocational Education (Grand Ball Room)

B. E. Lauer, University of Colorado, Boulder, Colo., *Chairman*

A. Recruiting of College Graduates

1. "Problems of the Recruiting Agent," by Dwight Durham, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
2. "Problems of the University Placement Director," by Gordon Sikes, Princeton University, Princeton, N. J.

B. Assimilation of the Technical Graduate Into the Industry

1a. "Through an Interview and Formal Training Program"
(Industries' View), by Robert Ralston, General Electric Co., Schenectady, N. Y.

1b. (New Employee's View), by Thomas Bink, General Electric Co., Schenectady, N. Y.

2. "Through a Short Formal Training Program," by O. A. Greiner, American Cyanamid Co., New York, N. Y.
3. "Through Immediate Job Responsibility"
(Industries' View), by E. L. Gibson, Carbide & Carbon Chemicals Corp., New York, N. Y.
(New Employee's View), by Seymour Rose, National Adhesives Co., New York, N. Y.

2:00 p.m. Fundamental Research (Room B-C)

Harry F. Lewis, Institute of Paper Chemistry, Appleton, Wis., *Chairman*

1. "Mechanical Behavior of Paper, Part I," by Geoffrey Broughton, and N. A. Matlin, Lowell Textile Institute, Lowell, Mass.
2. "Sorption of Water-Soluble Cellulose Ethers by Cellulose," by Ellsworth Shriver, Institute of Paper Chemistry, Appleton, Wis. (Mr. Shriver is now with the Mead Corp., Chillicothe, Ohio.)
3. "The Mechanism of Fiber Bonding," by W. S. Wilson, Monsanto Chemical Co., Everett, Mass.
4. "The Effect of Urea and Related Compounds on the Mechanical Properties of Paper," by Henry D. Fisher, Institute of Paper Chemistry, Appleton, Wis. (Mr. Fisher is now with the Scott Paper Co., Chester, Pa.)
5. "Paperboard Drying" (Investigation by Means of an Experimental Drying Machine), by Stanley F. Smith and B. W. Atwood, St. Anne's Board Mill Co., Bristol, England (By title).
6. "Determination of Iron in Wood and Wood Pulp," by R. M. Kingsbury, Forest Products Laboratory, Madison, Wis. (By title).

2:00 p.m. Paper Making (Fourdrinier) (East Ball Room)

Noel R. Phillips, Champion Paper & Fiber Co., Canton, N. C., *Chairman*

Symposium on "Fourdrinier Wet-End Variables."

1. "Slices," by Paul Boronow, Valley Iron Works, Appleton, Wis.
2. "Paper by B. L. Kassing, Nekoosa-Edwards Paper Co., Port Edwards, Wis.

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ROLLS — Farrel rolls are furnished in sizes from 5″ to 72″ in diameter and up to 312″ face length. They are made of various metals and metal alloys to suit different paper mill requirements. Send for Bulletin 116.

CALENDERS — Farrel paper-machine calenders can be made with rolls in any face length up to 312″. Board calenders are also available in a wide range of sizes, designed to suit your requirements. Bulletin 117 describes both types.

ROLL CALIPERS — Farrel roll calipers provide the quickest and most accurate means of checking roll diameter and crown, either when the roll is in or out of the grinder. They are made in five sizes for rolls from 4″ to 50″ in diameter. Write for Bulletin 112.

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....Bulletin 118 "FARREL TWO-WHEEL, SWING-REST ROLL GRINDERS"

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Company.....
Address.....
City..... State .....

WEDNESDAY, FEBRUARY 21, 1951

9:15 a.m. Statistics (Room B-C)

T. A. Pascoe, Nekoosa-Edwards Paper Co., Port Edwards, Wis., *Chairman*

1. "Statistical Techniques in Maintenance of Testing Instruments," by W. Edmund Patte, E. B. Eddy Co., Hull, P. Q.
2. "Case Studies in the Application of Industrial Statistics to Papermaking," by Charles A. Bicking and Richard T. Trelfa, Hercules Powder Co., Wilmington, Del.
3. "Sampling Plans," by Geoffrey Broughton and M. Kennedy, Lowell Textile Institute, Lowell, Mass.
4. "Nomographic Assistance in Statistical Calculations," by W. E. Patte, E. B. Eddy Co., Hull, P. Q.
5. "The Calculation of Mullen," by Edward R. Hoffman, Hammermill Paper Co., Erie, Pa.

9:15 a.m. Chemical Engineering (West Ball Room)

J. R. Lientz, Union Bag & Paper Corp., Savannah, Ga., *Chairman*

1. "An Industrial Lecture Program for Students of Chemical Engineering," by Lyle C. Jenness, University of Maine, Orono, Me.
2. *Symposium on Digester Construction and Operation*
   a. "Factors Influencing Service Life of Brick Linings in Sulphite Digesters," by Beaumont Thomas, Stebbins Engineering & Mfg. Co., Watertown, N. Y.
   b. "Corrosion Studies in Sulphate Digesters," by M. A. Scheil, A. O. Smith Corp., Milwaukee, Wis.
   c. "The Effect of Silica on Digester Corrosion," by J. C. Hair and A. W. Duskin, Crossett Paper Mills, Crossett, Ark.
   d. "Progress Report on the Activities of the Digester Corrosion Subcommittee," by H. O. Teeple, International Nickel Co., New York, N. Y.

9:15 a.m. Wet Strength (Room A)

K. W. Britt, Scott Paper Co., Chester, Pa., *Chairman*

1. "The Role of the Hemicelluloses in the Mechanism of Wet Strength," by M. N. Fineman, Rohm & Haas Co., Philadelphia, Pa.
2. "The Mechanism of the Improvement of Wet Strength of Paper by Polyethylenimine," by Paul A. Trout, Institute of Paper Chemistry, Appleton, Wis. (Mr. Trout is now with the American Box Board Co., Filer City, Mich.)
3. "Factors Affecting Retention and Efficiency of Wet-Strength Resins," by Representative of American Cyanamid Co., Stamford, Conn.
4. "The Rate of Wet Strength Development in Neoprene-Containing Papers," by G. C. Wheeler, A. M. Borders, G. R. Sears, and J. W. Swanson, Institute of Paper Chemistry, Appleton, Wis.
5. "Super-Wet Strength by the Beater Addition Process," by Francis H. Snyder, L. Spiwak, and A. E. Moyer, Snyder Chemical Co., Bethel, Conn.
6. *Panel Discussion on "Practical Aspects of Wet-Strength Paper Manufacture."*

9:15 a.m. Preparation of Papermaking Materials (East Ball Room)

F. S. Klein, Byron Weston Co., Dalton, Mass., *Chairman*

1. "The Influence of Temperature During the Beating Process," by O. K. Ronning, E. D. Jones & Sons, Inc., Pittsfield, Mass., and C. E. Libby, New York State College of Forestry, Syracuse, N. Y.
2. "Description and Action of the Morden Slush-Maker Pulper," by R. Burke Morden, Morden Machines Co., Portland, Ore.
3. "Pulping of Waste Papers and Pulp in the Dynopulper," by G. A. Peterson, Rice Barton Corp., Worcester, Mass.
4. "The Bird-Gibbs Clarifiner," by Sven Fahlgren, Bird Machine Co., So. Walpole, Mass.
5. "The Sandy Hill Peppy Peeler," by Douglas Philbrook, Northeast Pulpwood Research Center.
6. "Apparatus for Beating Paper Pulp by Crushing Fibers Without Friction," by P. Centerick, Papeteries de Belgique, Duffel, Belgium (By title).

2:00 p.m. Microbiological (Room B-C)

R. F. De Long, Marathon Corp., Rothschild, Wis., *Chairman*

1. "Relation of Red Slime to General Paper Mill Slime Control," by J. R. Sanborn, National Aluminate Corp., Chicago, Ill.
2. "A New Method for Detecting Slime in Pulp and Paper Mills," by Stanley J. Buckman and Virginia Henington, Buckman Laboratories, Memphis, Tenn.
3. "Pink Slimes in Paper Mills—Identification and Control of Causative Organisms," by John W. Appling, N. Jean Ridenaur, and Stanley J. Buckman, Buckman Laboratories, Memphis, Tenn.
4. Paper by Ernest Reed, Syracuse University, Syracuse, N. Y.
5. Paper by Representative of the Dow Chemical Co., Midland, Mich.

2:00 p.m. Acid Pulping (West Ball Room)

John M. McEwen, Pulp Div., Weyerhaeuser Timber Co., Everett, Wash., *Chairman*

1. "Commercial Sulphite Experience With Ammonia Base," by L. A. La Fond and W. F. Holzer, Crown Zellerbach Corp., Lebanon, Ore., and Camas, Wash., respectively.
2. "Progress Report on the Magnesium Bisulphite Process in Operation at Longview, Wash.," by C. E. Rogers, Babcock & Wilcox Co., New York, N. Y., and Svarre Hazelquist, Weyerhaeuser Timber Co., Longview, Wash.
3. "Chemical Reaction Equilibria in Calcium and Magnesium-Base Sulphite Recovery Systems," by Roy P. Whitney, Richard M. Elias, and Malcolm N. May, Institute of Paper Chemistry, Appleton, Wis.
4. "The Program of the Sulphite Pulp Manufacturers' League," by Averill J. Wiley, SPMRL, Appleton, Wis.
5. "The Determination of Solids in Sulphite Liquor," by a Member of the Acid Pulping Committee.

2:00 p.m. Paper Making (Cylinder) (East Ball Room)

J. J. Harrison, Michigan Carton Co., Battle Creek, Mich., *Chairman*

Panel Discussion on "Wet-End Problems and Operation of Cylinder Machines."

1. "Instrumentation and Control," by A. T. Luey, Sutherland Paper Co., Kalamazoo, Mich.
2. "Air Prevention and Elimination in Stock to the Vats," by Representative of the Ohio Boxboard Co., Rittman, Ohio.
3. "Wire Marks—Their Cause and Means of Elimination," by Glen T. Renegar, Container Corp. of America, Manayunk, Pa.
4. "The Mechanism of Stock Formation on a Cylinder," by Frank Hollis, Alton Boxboard Co., Alton, Ill.

2:00 p.m. Fibrous Agricultural Residues (Room A)

S. I. Aronovsky, Northern Regional Research Laboratory, Peoria, Ill., *Chairman*

1. Paper on the Preservation of Straw.
2. Paper on Bamboo, by Representative of the New York State College of Forestry, Syracuse, N. Y.
3. "Mechano-Chemical Pulping—Reaction Rates," by Representative of Northern Regional Research Laboratory, Peoria, Ill.
4. "Boxboard from Wheat Straw to Replace Wood Veneer in

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PQ SILICATES OF SODA

Wire-Bound Shipping Containers," by E. C. Lathrop, T. R. Naffziger, and Earl R. Stivers, Northern Regional Research Laboratory, Peoria, Ill.

5. "Agricultural Residue Pulps—Crotalaria Pulps," by A. J. Ernst, H. M. Sutcliffe, and S. I. Aronovsky, Northern Regional Research Laboratory, Peoria, Ill.

THURSDAY, FEBRUARY 22, 1951

9:00 a.m. Mechanical Pulping (Room B-C)

F. W. O'Neil, New York State College of Forestry, Syracuse, N. Y., *Chairman*

1. "Hydrogen Peroxide Bleaching of Chemical and Mechanical Pulps," by R. L. McEwen, F. R. Sheldon, and D. H. Nelson, Buffalo Electro-Chemical Co., Inc., Buffalo, N. Y.
2. "Peroxide Bleaching of Groundwood and Sulphite Pulps," by R. A. Premo, Gould Paper Co., Lyons Falls, N. Y.
3. "Color Removal of Process Water," by J. H. Davidson, Minnesota & Ontario Paper Co., International Falls, Minn.
4. "The Vibrotor Screen," by Sven Fahlgren, Bird Machine Co., So. Walpole, Mass.
5. "Effect of Recycling Spent Liquor in Semichemical Pulping," by E. L. Keller and J. N. McGovern, Forest Products Laboratory, Madison, Wis. (By title).
6. "Poplar Growth and Its Utilization in Papermaking in Italy," by Representative of Cartiera Burgo, Torino, Italy (By title).

9:00 a.m. Microscopy (Room A)

C. E. Brandon, Howard Paper Mills, Inc., Dayton, Ohio, *Chairman*

1. "Routine Fiber Analysis of Pulps, Papers and Paperboards," by Norval F. Wilson, Alton Box Board Co., Alton, Ill.
2. "An Optical Projection Method for Measuring Fiber Length," by Thomas Fyfe, Eastman Kodak Co., Rochester, N. Y.
3. "The Microscopy and Identification of Synthetic Fibers," by F. D. Houghton, American Viscose Corp., Marcus Hook, Pa.
4. "The Microscopic Identification of Paper Fillers," by Harold C. Koch, C. Edwin Brandon, and Kenneth P. Geohegan, Howard Paper Mills, Inc., Dayton, Ohio.
5. "Some Unconventional Uses of the Microscope on Wood and Its Fibrous Products," by T. G. Rochow, American Cyanamid Co., Stamford, Conn.
6. "A Proposed Card Sorting System for the Identification of Pulpwoods," by B. Francis Kukachka, Forest Products Laboratory, Madison, Wis. (By title).

9:00 a.m. Graphic Arts (West Ball Room)

Fred D. Elliott, Time, Inc., Chicago, Ill., *Chairman*

Methods of Testing Symposium

1. "Measuring Printing Quality of Magazine Paper," by Emery Braugh, Time, Inc., New York, N. Y.
2. "Numerical Evaluation of Printability of Paperboard," by Clyde Eckhart, Ohio Boxboard Co., Rittman, Ohio.
3. "Measuring Printing Quality of Newsprint," by Gerard Larocque, News Syndicate Co., New York, N. Y.
4. "Development of a Test for Evaluating the Bonding Strength of Coated Papers," by W. W. Roehr, Kimberly-Clark Corp., Neenah, Wis.

1:00 p.m. Annual Luncheon (Grand Ball Room)

A. E. Bachmann, *presiding*

1. Presentation of the TAPPI Medal to George H. Tomlinson, Howard Smith Paper Mills, Montreal, P. Q., by J. N. Stephenson, Pulp and Paper Magazine of Canada, Gardenvale, P. Q.
2. "The International Situation," by J. D. Zellerbach, Crown Zellerbach Corp., San Francisco, Calif.

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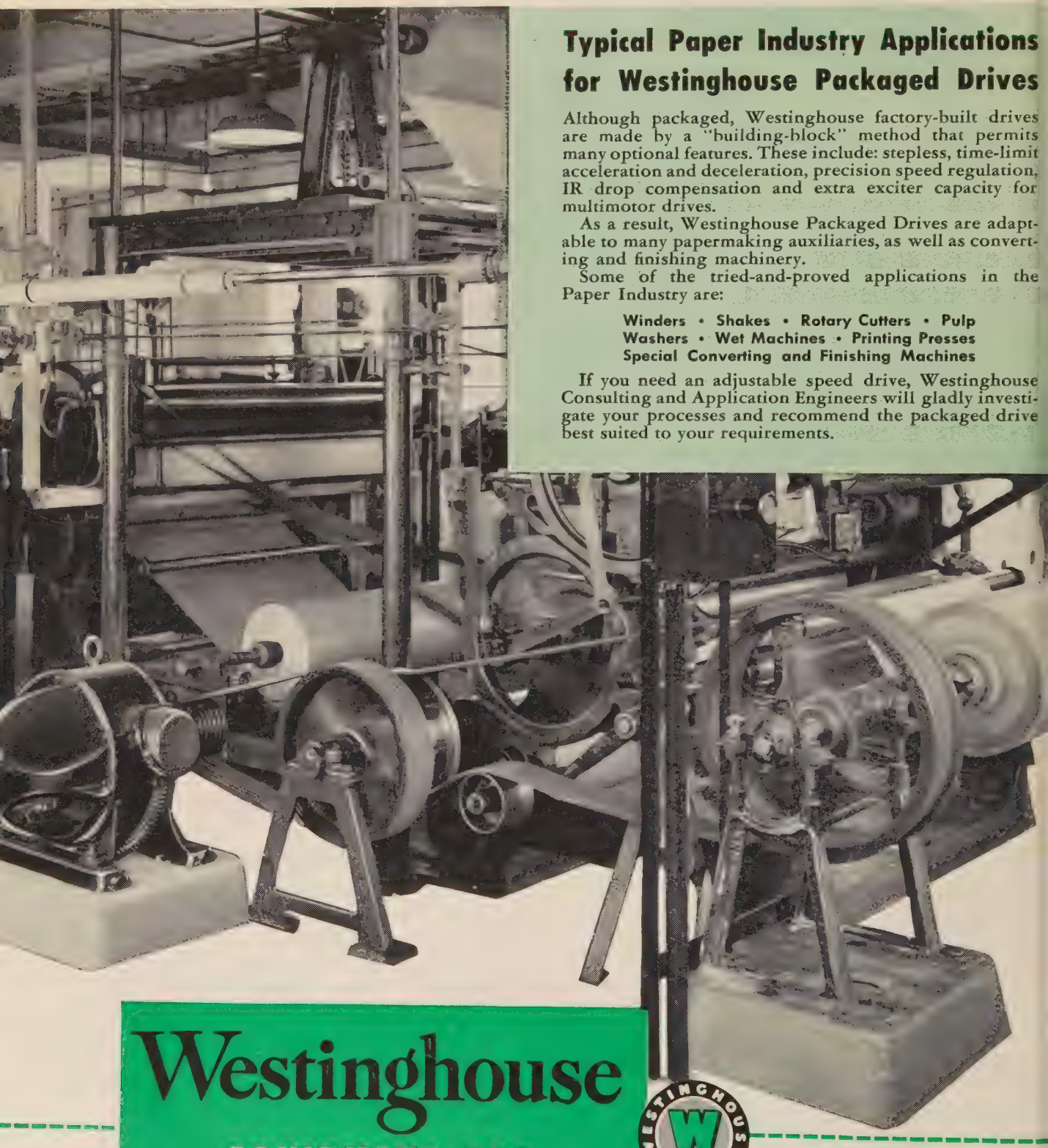

Typical Paper Industry Applications for Westinghouse Packaged Drives

Although packaged, Westinghouse factory-built drives are made by a "building-block" method that permits many optional features. These include: stepless, time-limit acceleration and deceleration, precision speed regulation, IR drop compensation and extra exciter capacity for multimotor drives.

As a result, Westinghouse Packaged Drives are adaptable to many papermaking auxiliaries, as well as converting and finishing machinery.

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Winders • Shakes • Rotary Cutters • Pulp Washers • Wet Machines • Printing Presses Special Converting and Finishing Machines

If you need an adjustable speed drive, Westinghouse Consulting and Application Engineers will gladly investigate your processes and recommend the packaged drive best suited to your requirements.

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EQUIPMENT FOR THE PAPER INDUSTRY

YOUR CHOICE

of Packaged Drives with Westinghouse

For many paper machinery applications requiring a packaged drive, the improved performance desired can be obtained by using the type having an M-G set. Other machines require the all-electronic type for top performance.

With Westinghouse, you can have your choice:

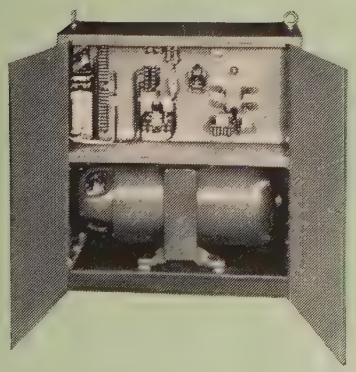
AV Life-Line Packaged Drive. This drive, using an M-G set, gives adjustable speed control up to a range of 16 to 1. It is a simple, factory-wired package housed in one self-ventilated cabinet. It is economical in every way—first cost, installation, power consumption, maintenance and floor space.

Mot-O-Trol. This packaged, all-electronic adjustable speed drive is designed for use with those machines that require extreme speed ranges up to 100 to 1, or precise speed regulation to as little as plus or minus ½%. Its heavy-duty components and simplified circuits assure trouble-free service under difficult mill conditions.

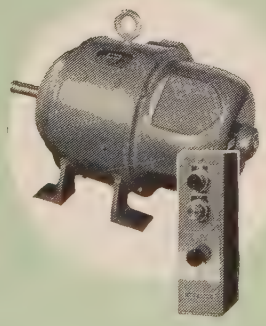
Both drives give you fast, smooth operation of those machines for which they are made. Each one is backed by Westinghouse unified responsibility for complete drive performance *as a drive.*

Besides drives—packaged and tailor-made—Westinghouse makes a complete line of electrical equipment for the Paper Industry. No matter what your needs, Westinghouse can supply them. Call your nearest Westinghouse District Office, or write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-94798

ESSENTIAL ELEMENTS OF WESTINGHOUSE PACKAGED DRIVES

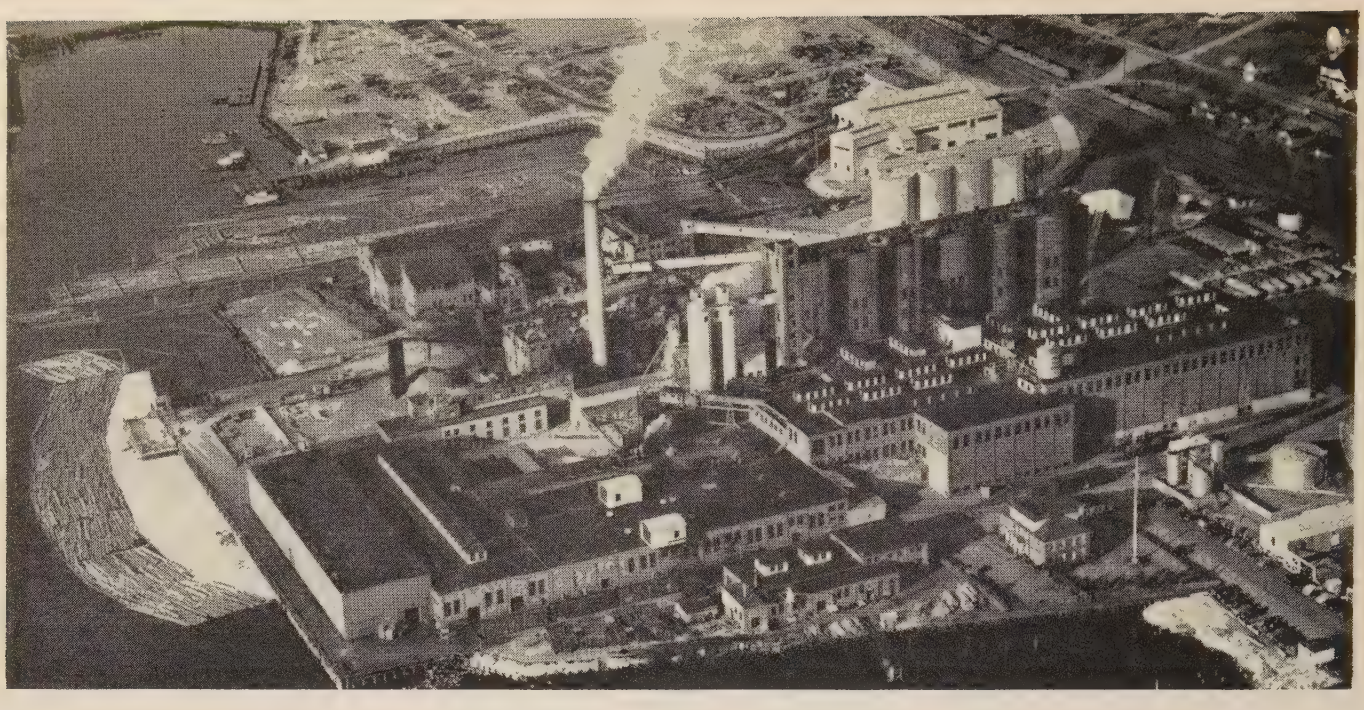


This compact, freely-ventilated cabinet for the AV Life-Line Packaged Drive houses the complete power unit. The motor-generator set for power conversion, dynamically balanced to eliminate vibration, is rubber mounted in lower compartment. Cooling air for the M-G set is drawn through filters which are easily replaced.



Motor and control for either drive. Motor is standard SK Life-Line, d-c motor with bearings which require no lubrication. Operator's station with combined start-stop push-button and speed control knob—an exclusive Westinghouse feature—can be installed where most convenient. Reversing and inching are optional.

This is the self-ventilated Mot-O-Trol cabinet, containing all necessary circuits for the complete control of motors. Because of simplified circuit design, Mot-O-Trol has fewer tubes, potentiometers, resistors, capacitors and Rectoxes than any similar equipment. Rugged, industrial components resist vibration and give longer life.



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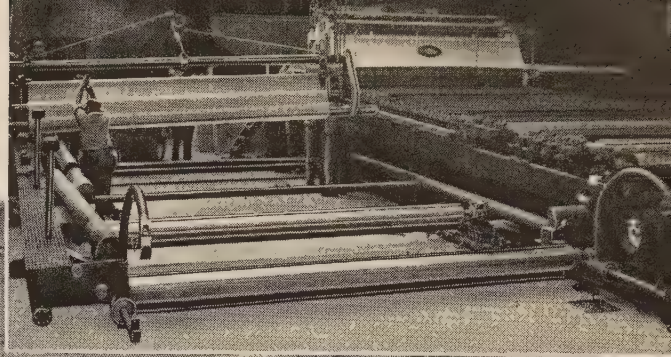
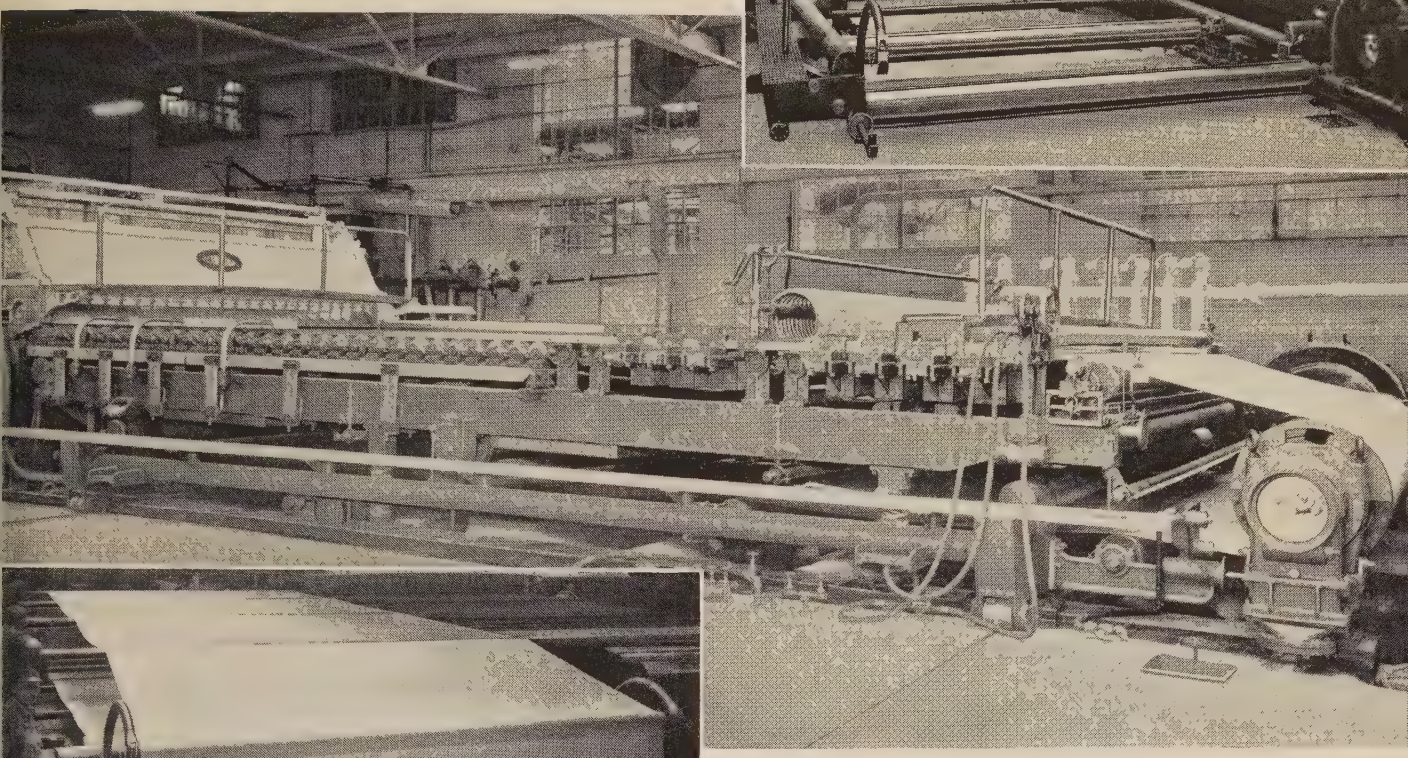
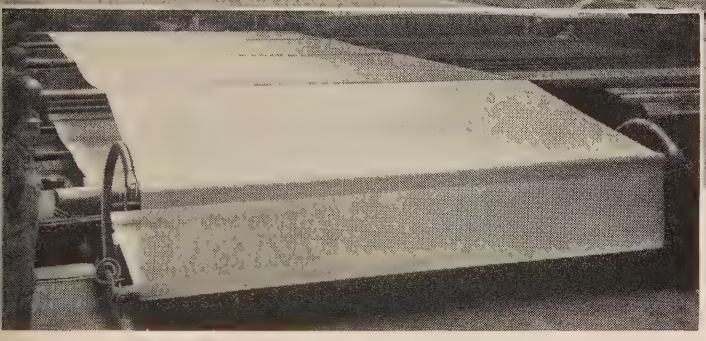
At right: undercarriage rolled into tending side aisle on suitable tracks ready for wire draping operation.







Above: Fourdrinier Part of improved "Rapi-Drape" design shown in operating position.

At left: wire draped on undercarriage ready for installation.

Wire Changing Time:

55 Minutes

Here is a simplified, fast, safe method of changing Fourdrinier Wires. Down-time is greatly reduced. Operators report a complete wire change in 55 minutes or less. Takes less aisle space and there are no heavy parts to handle. No danger of deflection stresses or distortion as experienced with complete removal or cantilever change. Unnecessary to disconnect shake connections, suction boxes or showers.

In "Rapi-Drape" Wire Handling, pioneered by Puseyjones, the Fourdrinier as a unit remains in the operating position. The breast roll and the stretch roll are lowered, and the couch roll cantilevered to provide clearance. The back of the Fourdrinier is supported on frames. Features include a removable, power-operated undercarriage which supports the front side in perfect alignment at all times. Only parts which must be removed are the dandy roll, deckle and cut squirts.

Get the complete "Rapi-Drape" story . . . talk to a Puseyjones engineer.

"Rapi-Drape" Wire Handling is now being used successfully in these outstanding mills:

Southland Paper Mills, Inc., Lufkin, Texas
Hollingsworth & Whitney Company, Mobile, Ala.
Southern Advance Bag & Paper Co., Hodge, Ala.
St. Mary's Kraft Corp., St. Mary's, Ga.
Union Bag & Paper Corp., Savannah, Ga. (2)
Hudson Pulp & Paper Co., Palatka, Florida (2)
Southern Paper Board Corp., Port Wentworth, Ga.
Fibreboard Products Inc., East Antioch, Cal.
St. Regis Paper Co., Tacoma, Wash.
Calcasieu Paper Co., Elizabeth, La.
San Rafael Paper Co., Mexico, D.F.
Papierfabrik Utzenstorf, Switzerland
National Newsprint Co., Ltd., India
Everett Pulp & Paper Co., Everett, Wash.

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TAPPI Nonfibrous Raw Materials Report—1950

E. N. POOR

Pulp demand is running 30% ahead of the corresponding period in 1949. This change coupled with the expanding requirements of the armed forces and the strikes in the alkali industry has resulted in a tight situation for many of the chemicals used by the paper industry. Furthermore, prices have tended to increase in some instances. Until the needs of the military level off we cannot expect much stability in the raw material supply situation.

CAUSTIC SODA

Availability—Caustic soda has been extremely short during the past few months as result of strikes at two of the major producers plants. In addition, the caustic consuming industries have been operating at a high rate of speed. With the resumptions of operations at the closed plants, additional tonnages are available, however, the caustic supply has not yet reached a balance with the demand. The supply and demand should fairly well balance by the end of the year.

Price changes—Prices were increased July 1 and Oct. 1. Future price changes will be dependent upon general business conditions and the extent to which inflation takes place.

New uses—There are no new uses of caustic soda of a significant nature. The present major uses are expanding in volume.

Substitutes—In most cases there are no real substitutes for caustic soda. Under certain conditions of a large scale use, soda ash can be causticized with lime to form caustic soda, however, this process is not used where quality is important.

Outlook for 1951—The outlook for 1951 is largely dependent upon the magnitude of the defense efforts and general business conditions. In all probability, the business level will remain high and the caustic soda demand will keep the supply-demand pretty much in balance. There may be local surplus stocks, and a general decline in business conditions that rather quickly result in surplus caustic.

SODA ASH

The market for soda ash is in short supply due to strikes in several of the major suppliers' mills, as well as to the demand caused by the rearmament program. Labor conditions have now been settled, and soda ash production should again reach its maximum the latter part of October. It is believed that short supply will continue through 1950 and probably through 1951 as warehouse and mill storages are empty.

An upward revision of price change occurred in July, 1950, and another on Oct. 1, 1950. Light soda ash, in bulk, as of Oct. 1, 1950, is quoted at $1.20 per cwt. f.o.b. plant.

On Oct. 1, 1949, the major producers adopted a one-price policy for carloads of soda ash regardless of tonnage purchased. This resulted in price reductions for many consumers.

Substantial quantities of soda ash have been used in semichemical pulping and in replacement of salt cake in the kraft industry. It is expected that the semichemical pulping process will continue to expand materially during the coming years.

Soda ash continues to be the cheapest and most commonly used form of alkali for pulp and paper manufacture. It can be converted readily to caustic soda, sulphite, sulphide, or hypochlorite, basic chemicals used in the industry. No economic substitute has been found to replace soda ash.

LIME

The price of lime and limestone increased this year, but it is not likely there will be further increases unless the cost of manufacturing continues to expand.

Limestone is being used by some kraft pulp mills to burn along with the carbonate sludge, thereby supplying the mill with the necessary make-up lime. To determine if this is economical or not depends on how close a pulp mill is located to a good supply of clean high-calcium limestone and the delivered cost of the stone on a calcium oxide basis.

In some sections, lime is fairly tight, but the over-all picture seems to indicate that there is sufficient lime tonnage to take care of the demand during the present government rearmament program.

During 1950 and 1951, the big problem seems to be to get sufficient box cars to load lime, and regular customers of lime could assist by requesting bulk quick lime cars loaded to capacity and hydrated lime customers requesting 30-ton minimum cars.

SULPHUR

Availability—Demand for sulphur has been in excess of producers' ability to supply, mines' stocks have been decreasing for the past several years, and the demand continues to increase. No substantial additions to supply have been made by the discovery of new deposits, therefore, at the moment, there is a definite shortage.

Price changes—Freeport Sulphur Co., has announced an increase in the price from $18 to $22 per long ton, f.o.b. cars mines.

New uses—No substantial new uses have been developed.

Substitutes—No substitutes are known to have been developed.

Outlook for 1951—With demand continuing to increase faster than supply can be expanded, some allocation is to be expected in 1951.

SULPHUR DIOXIDE

Availability—The total productive capacity of liquid sulphur dioxide for sale in the United States has been

E. N. Poor, Member TAPPI; Chairman, TAPPI Nonfibrous Raw Materials Committee; Hudson Pulp and Paper Corp., Augusta, Me.

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METHOCEL...a superior synthetic gum!

One test of any paper coating is its ability to bind to the stock. Because Methocel (Dow Methylcellulose) is a better binder, it is the choice of an ever increasing number of paper producers for specialty coating applications.

Methocel has an inherent ability to produce a smooth, tough, clear, flexible film, binding clay and other pigments to paper and paper board. The exceptional film forming properties of Methocel are shown by its high sizing power to oils, greases and waxes. Light solutions of Methocel produce marked resistance to penetration of gloss inks, varnishes, solvents and waxes.

Methocel . . . the chemical of ever-growing usefulness . . . holds many other advantages for the paper producer. It is an efficient suspending agent that is highly useful in suspending pigments in colors. It is an excellent thickener and stabilizer, valuable in controlling the flow properties of latices and in stabilizing emulsions.

If you have not yet tried Methocel in your paper processing, send for a free, experimental sample of Methocel, *powdered*, plus valuable information on its many uses in the paper industry. Write Dept. ME41 stating approximate viscosity desired.

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increased somewhat during the year 1950. This increase has resulted from two sources: (1) increased production of old producers, and (2) added production resulting from a new producer entering the field. The availability picture appears favorable for the balance of this year and into 1951, unless some unpredictable changes occur. There may be current shortages due to limited availability of tank cars and haulage equipment. Recently there has been some question of reduced availability of elemental sulphur. If this materializes, then, of course, sulphur dioxide may be cut proportionately.

Price changes—Unlike the pattern of most manufactured goods, sulphur dioxide prices did not increase during 1950. In some categories actual price reductions were effected. These, however, were of minor import. At this writing it is impossible to predict the price picture for 1951 since it hinges on raw material price and availability and labor, both of which variables are at the moment indeterminate.

New uses—During 1950 there were no totally new uses developed for sulphur dioxide. There were, however, extensions and increases in the consumption for known applications. The chlorine shortage in the paper industry led to the necessity of experimentally substituting sulphur dioxide for one step in the chlorine bleach process. While this is still experimental, it appears highly promising and may result in an increased demand.

Substitutes—There have been no substitutes developed during 1950, nor is it likely that substitutes will be developed for this very basic material.

Outlook for 1951—As indicated under the several headings listed above, the outlook for 1951 is for continued availability of sulphur dioxide with probable periodic shortages due principally to the limitation of transportation equipment. The currently threatened setback in sulphur availability will, of course, be reflected in lowered sulphur dioxide output for 1951 if it materializes.

CHLORINE

Availability—Chlorine was in great demand throughout 1950 and two strikes, one of which lasted 100 days, cost a production at the rate of 9000 tons per month. Chlorine was in short supply prior to the strikes, and the losses caused by strikes cannot be made up by increased production.

Price changes—Inasmuch as the Chlorine Institute does not under any circumstances concern itself with prices, terms, or conditions of sale, it is clearly impossible for the correspondent to offer any information or comments with respect to this item.

New uses—The new uses of chlorine are almost entirely in the field of organic chemical manufacture. While there were a few instances where old uses declined, the new uses plus the demand for uses long established took care of the losses and a shortage still prevailed.

Substitutes—No substitute for the bulk of the uses of chlorine was found in 1950.

Outlook for 1951—Contingent on the ability to secure apparatus and plants in 1951, there will be an increase of around 20% of the present gas capacity building. Some of this gas will be liquefied. That this large increase will be enough is unpredictable.

PEROXIDES

Availability—The consumption and availability of hydrogen peroxide and sodium peroxide are keeping pace with general market conditions.

Price changes—The market prices for both hydrogen peroxide and sodium peroxide have increased about one cent per pound in 1950.

New uses—Peroxide bleaching of groundwood, as well as mixtures of groundwood and sulphite pulps, is increasing in tonnage.

There has been an expansion in the application of peroxides in the recovery of waste papers containing a substantial percentage of groundwood.

Peroxide processes for bleaching sulphite and sulphate (kraft) pulps are being put into successful commercial operation.

Substitutes—Zinc hydrosulphite and hypochlorites are being used for special applications in the bleaching of groundwood, e.g., zinc hydrosulphite for west coast woods and hypochlorite for hardwoods.

Outlook for 1951—The peroxide supply is expected to be adequate for 1951 requirements. Substantial expansions in the different applications of peroxides in the pulp and paper industry are expected in 1951.

ROSIN

A very important change has occurred in the rosin supply position during 1950. In 1948 and 1949, production exceeded demand, and large quantities of gum rosin were accumulated under the loan program. The Commodity Credit Corp. took over these loan stocks and owned about 750,000 drums of gum rosin at the start of the producing season on April 1, 1950.

It was generally expected that production would continue to exceed demand during 1950, to some extent at least, and experience during April, May, and June indicated that such would be the case. Prices declined, and it seemed probable that the loan program would again accumulate gum rosin during the summer months when production is normally heaviest.

A drastic change took place during July, perhaps as a result of the war in Korea. Demand exceeded production, and instead of taking rosin into loan stocks, heavy sales have been made by Commodity Credit Corp. from the supplies accumulated previously. By Sept. 30, C.C.C. stocks were reported to have declined to 475,000 drums. In the meantime, production of gum rosin is lower than last year.

The above does not necessarily mean that a shortage is imminent. The C.C.C. stocks on Sept. 30 constituted a sizable reserve, and while gum rosin production has declined, the decrease is more than offset by higher production of pale wood rosin which is interchangeable in many uses. Also, there is reason to believe that sales have exceeded actual consumption.

However, the situation is much firmer than has been the case in recent years, and it is natural that this has resulted in a material increase in price from the low point reached in June, 1950. If demand continues, and especially if Commodity Credit Corp. freezes any portion of its reserve stock, further increases in price are logical.

CASEIN

Continued government support of nonfat dry milk

BULLETIN NO. 250

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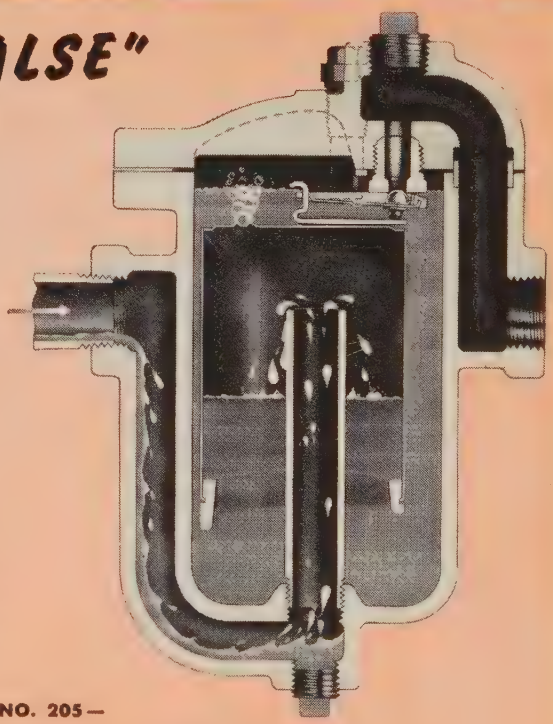

ARMSTRONG NO. 813-D Paper Machine Dryer Trap — NEW and BETTER! Bulletin No. 205 explains the difference between this trap and other traps, including the *standard* Armstrong Steam Trap.

ARMSTRONG MACHINE WORKS

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solids in 1950 has again curtailed domestic casein production, and during the first 7 months, output totaled only 13,810,000 pounds, or approximately 8% less than during the same period in 1949. However, despite limited availability of domestic material, total supply through this period was adequate as a result of unusually heavy importation of foreign casein. The outlook for the balance of the year is somewhat clouded, although in spite of stimulated consumer demand following the beginning of hostilities in Korea, no critical shortage seems imminent. Currently world supplies are somewhat depleted, but "flush" season production in Argentina is expected to relieve the situation considerably.

Prices fluctuated within a very narrow range through the first 6 months of 1950 with prime domestic material quoted generally at approximately 23¢ to 23½¢ per pound and Argentine 19 to 21¢ per pound. Beginning early in July, however, prices rose rapidly and by late September had reached a level of approximately 36¢ per pound for domestic and 37¢ per pound for Argentine. With limited stocks being closely held, it seems quite probable the market will remain firm through the balance of the year although some price weakness could develop should the Argentine "flush" production run heavier than normal.

Prospects for 1951, as regards price and availability, are obscure at this writing. As was the case one year ago, little is known concerning the attitude of the government with regard to dairy products price support. Assuming the present nonfat dry milk solids program will be continued, without adjustment, beyond its expiration date of March 31, 1951, it is doubtful domestic casein production volumes will exceed the total for 1950, and prices will probably remain firm. On the other hand, lower support prices and a restricted purchase program for nonfat milk powder would undoubtedly be reflected in increased casein production and reduced sales prices. The possibility of further world conflict with resulting federal allocation and price controls are additional considerations which could affect both availability and price trends.

ALUM AND SODIUM ALUMINATE

Commercial alum

During the first half of 1950 the consumption of alum was high but, in general, all requirements were met. Beginning about July 15, the consumption of alum by the paper industry was increased, and a shortage developed. It is expected that the shortage will continue because of the high level of paper and paperboard production. There has been no change in the supply or users of alum during 1950. The price has advanced about 10% to cover increased labor and raw material costs.

Iron-free alum was also short during the latter part of 1950 because of increased consumption by established uses. In view of continued high paper and pigment manufacturing level, the shortage is expected to continue in 1951.

Sodium Aluminate

Plant capacities for the manufacture of sodium aluminate are ample to cover the requirements for the product, but the extreme shortage of alkalies during the latter part of 1950 resulted in insufficient supplies of the material. The supply in demand position during 1951 will depend upon the availability of alkalies and other raw materials.

GLUE

Since the outbreak of the Korean War, the demand for animal glue has exceeded supply and producers are required to limit the acceptance of orders. Although all users have not been able to purchase animal glue in unlimited quantities, it is believed that there has not been any curtailment of production by users because of the short animal glue supply situation. The animal glue industry is operating at capacity and with good prospects for adequate supplies of raw materials, production should continue at the present rate for some months to come. This being the case, actual use requirements of customers will likely be met in the entirety from current production.

The animal glue industry has not been able to accumulate any inventory at all since animal glue was released from allocation after World War II, and although inventories in the possession of producers are considerably below normal inventories which has a tendency to ease the pressure and enable producers to make rush deliveries to those in most urgent need.

Although animal glues have recently advanced in price, the increases are far below the average of most other commodities and it is believed the market is pretty well stabilized at present levels. Increase in prices of animal glue have been necessitated wholly due to increases in the cost of raw material, labor, coal, and freight, and have not been encouraged through the short supply.

The current demand for glue is not as excessive as it was at the start of the Korean War and with the anticipated capacity production during the winter months, some relief is expected in the supply situation during the early part of 1951, unless a major war program is undertaken whereby animal glue, along with many other items, may be channeled to uses by government orders that do not now exist.

STARCH

Availability is tight, and prices are moving up slowly. There are no new uses. Potato and tapioca starches are being used as substitutes. There is a short supply for 1951.

DYESTUFFS

Although sales so far this year are up 35 to 40% over 1949, there has been no significant shortage of dyes used by the paper industry. During July, August, and September, sales have increased considerably over the first 6 months probably because it was considered advisable to carry higher inventories than during the first part of the year, and also because of price increases taking effect in the fourth quarter which caused some advance buying.

Dyestuff prices on some dyes were increased to take effect on Oct. 1, due to wage increases and higher costs on basic raw materials.

A process for coloring paperboard was developed which brought forth new uses for certain basic, direct, and acid dyes. Shades having good wet fastness have

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been made by incorporating the dyes in a starch paste which is applied to the board by a wire wound roll.

No substitutions were necessary because, on the whole, adequate supplies were available.

The outlook for the coming year is quite uncertain because of possible restrictions and shortages of strategic raw materials. It would appear that there will be a greater demand for the uncolored tonnage items, with a consequent reduction in the production of colored papers. Shortages of raw materials may affect dyestuff production but it is believed that supplies will be sufficient to take care of the paper industry's requirements.

STARCH CONVERTING ENZYMES

The use of starch-converting enzymes continues to increase with the trend being toward the concentrated types. These usually are priced somewhat lower per unit of converting strength. Such concentrated enzymes are now available in small premeasured units as well as in bulk form. Production of the higher-cost, low-strength enzymes has been discontinued by some manufacturers.

Use of the concentrated enzymes has permitted a price reduction per unit of converting strength to an all-time low. The supply of amylolytic enzymes is ample to meet all normal demands.

CLAY

Domestic coating and filler clays continue in good supply, and no difficulty is anticipated in satisfying increased demands in sight at present.

Regular and intermediate-grade coating clays increased about 10% in price in the early Autumn. No changes in price of filler grades or No. 1 polishing clay have been announced.

The utility position of clays in the paper industry is unchanged, neither substantial new uses nor important substitutes having appeared.

It is confidently expected that the domestic clay producers will continue to maintain production adequate to all needs, both as to quantity and quality, for all papermaking purposes.

ZINC SULPHIDE PIGMENTS

The threatened increase in mailing costs has emphasized the interest in obtaining lighter weights of paper without a sacrifice of opacity, and this has contributed to the continuing demand for these pigments.

In common with most other raw materials for industry, the situation in lithopone is tight. For those numerous uses where a higher filler content of the paper is permissible, and for coatings, for which it is well adapted, lithopone may be more available at some future time.

In the last year there has been only a slight change in the price of this material, lithopone now selling for 7¢ per pound in carload lots.

It is well recognized that none of the commonly used fillers can compete in performance with the high strength pigments, such as the zinc sulphides, where a high degree of whiteness, brightness, and opacity is desired. For those specialty uses where the paper industry continues to prefer technically pure zinc sulphide, it will be in comparatively tight supply at 24¢ per pound.

TITANIUM PIGMENTS

As with many other raw materials, the demand for them is in excess of supply so titanium pigments are today being allocated.

Up to this time there has been no change in price but with ever increasing costs the trend is more apt to be upward rather than downward.

Uses for titanium pigments in the paper industry remain much the same as to types but volume has continued to show gain. Of the several types used, the straight titanium dioxide pigment is the preferred one.

For 1951, with the high consumer demand for products in which titanium is used, together with the new defense program, we expect it to remain in short supply and under some system of allocation.

SYNTHETIC RESINS

Early in 1950 business was fair to good in the field for synthetic resins in the paper industry. In particular, both melamine and urea-formaldehyde resins for the wet-strength field were increasing in their usage as new applications were found in the field. The urea resins for wet strength became publicized and promoted widely in the field due to the renewed efforts of many new manufacturers of urea wet-strength resins. Total volume of resins used in the first 6 months of 1950 was considerably over that used in the first 6 months of 1949 and was even ahead of the amounts used in the last 6 months of 1949. With the change in the supply picture for all of us due to the Korean war situation and due to the increased efforts of the government to build up military supplies, we found the paper industry increasing its output up to its limit. In some cases this has retarded the growth of specialty items. However, there are "war-type" papers which now are consuming resins. The V-box is back and wet-strength resins are required in this box to meet the wet burst specifications of the box. The famous Army map paper requirements have been jumped many times over the small amount that has been made since the last war, and large quantities of resin are used by this outlet. Overseas shipping sacks will require wet-strength papers and offer another drain on the available supplies of urea and melamine resins. In a cumulative manner these will drain quite a bit of resin away from civilian use. Currently, melamine resins are used practically to the limit of the availability of the melamine. Some relief is in sight by the first of the year. Urea supplies have been allocated to contrast commitments by the major supplier. A new source of supply is due to start appearing on the market at least by Nov., 1950, and this will alleviate the situation some. However, in general, urea remains tight and a widely expanding civilian use looks improbable. The formaldehyde situation, however, as of the moment appears adequate to supply all the resin requirements.

Prices in general are advancing. Prices on the melamine resins so far have remained firm and probably will be firm over the balance of 1950. Urea resin prices are advancing because of increased cost of urea and increased cost of formaldehyde as well as increased labor cost in the manufacturing plants. In general we feel that the price situation through 1950 and during the first half of 1951 will remain somewhat firm with

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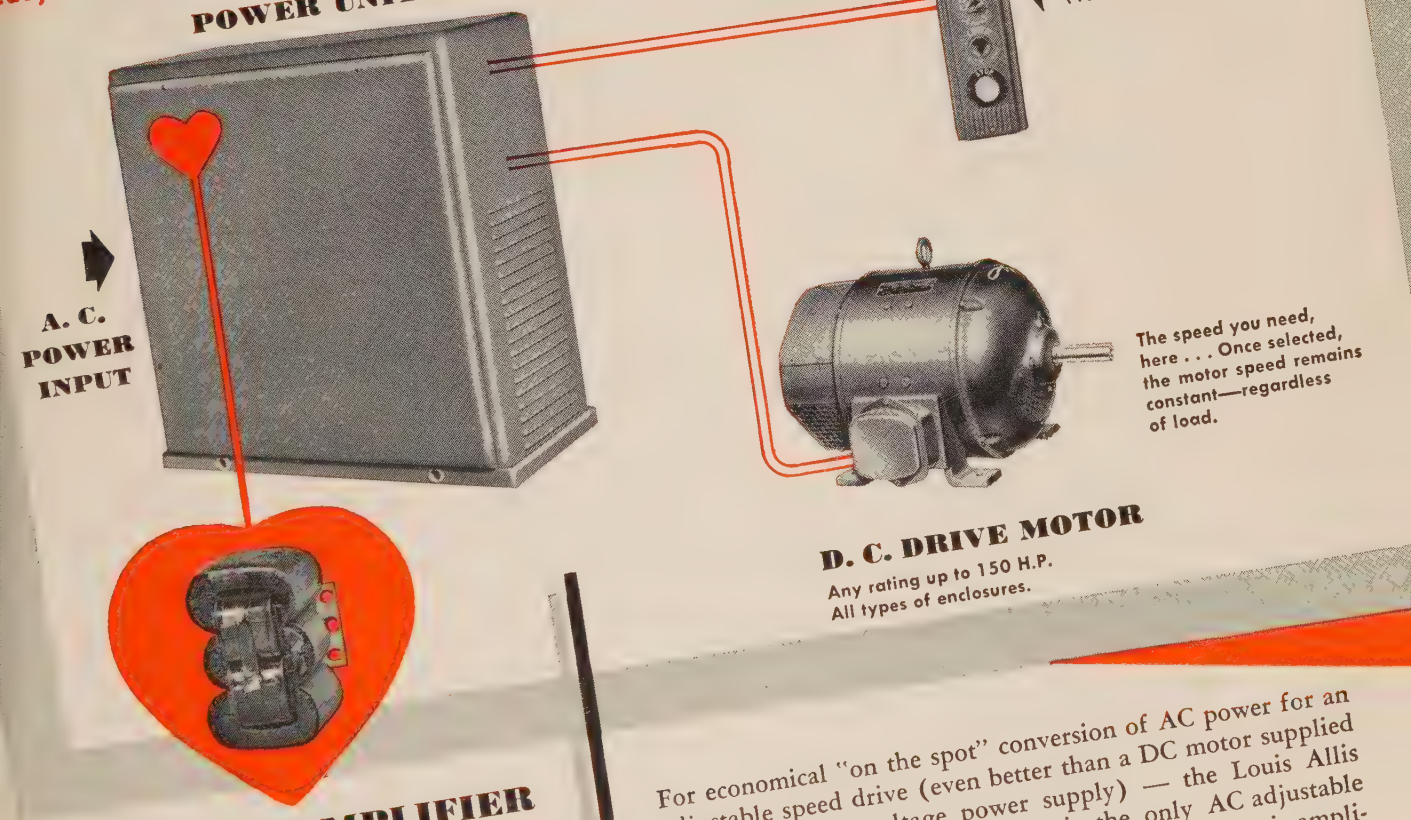
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increases only as raw materials increase and, of course, if labor and manufacturing costs increase.

Although the first half of 1950 showed a strong interest by the papermakers to evaluate the use of wet-strength resins for many new uses, it is highly probable that with the rush of business experienced by the paper mills and the none too plentiful supply that new developments will be slowed considerably in the latter part of 1950 and early part of 1951.

The use of the synthetic resins of the melamine and urea-formaldehyde types for dry-strength improvement in paper is a very interesting potential. The fiber bonding effect of the resin offers many chances to the papermaker to increase the strength of his paper without hydration which adds many valuable properties to that paper.

There were no basically new wet-strength resins which appeared on the market in 1950.

The outlook for 1951 is pretty much dependent upon the war situation. Certainly an all out war will find controls back on synthetic resins. If, however, government requirements are not stepped up much beyond the point that they are now, it is probable that increased supplies of the resin will be available in early 1951. Both the improved melamine production picture and the improved urea production picture will account for this encouraging prediction.

Availability—During early 1950, paper production was at a high level, but not sufficiently high to tax the ability of resin manufacturers to meet demands. As the year ends, this situation still remains, although there are some tight supply situations in basic chemicals from which the synthetic resins are made. While these may affect supply substantially at a later date, this does not appear likely at the present time.

Prices—There were no large changes in the prices of synthetic resins to be used by the paper trade during the first half of 1950, although some suppliers have advanced prices as the year draws to a close. This may well prove to be a temporary situation.

New uses—The use of synthetic resins in paper manufacture expanded considerably during 1950, but the development was more of an exploitation along logical lines in established application, rather than revolutionary new applications. Thus, resins continued to be used as ingredients in coatings and sizes to impart water resistance, for strengthening towels, glassine, bags, twisting tissue, tea bags, locker and butcher wrap, mats, and saturating stocks when wet. Wider acceptance of the soundness of paper which retains its properties under nondry use conditions will undoubtedly continue to expand application possibilities in these fields.

Substitutes—No significant substitutes for urea formaldehyde and melamine formaldehyde resins in general wet strengthening has appeared, although a number of new resins in those classifications have been introduced in manufacture during 1950. The trend is definitely toward the use of cationic resins in this respect.

On the other hand, significant exploitation of synthetic latex for precipitation on pulp has begun. It appears at the present time that this development will not compete with established business where wet-strength resins are used, but that it will have wide use in enabling elimination of the saturating operation which is now carried out as a separate step in making many paper-rubber-resin stocks.

Outlook for 1951—It may be assumed that chemical manufacturers will continue active research efforts toward the production of new and interesting resins for the paper industry. A primary aim in this respect will be improved efficiency at lower cost. Developments now in progress point to continued success in achieving these aims as well as the ability to offer to the paper manufacturer a range of rates of cure and, hence, rates of development of strength characteristics, all at savings in terms of total cost.

WAX SIZES

As far as the availability of wax sizes are concerned, we have had no trouble so far and we do not anticipate any trouble unless drastic government controls are inaugurated.

There have been some price changes and there will be more. The price of wax has advanced twice in the past 2 months and naturally these advances are reflected immediately in the price of the finished emulsion.

One new use that has come to attention is the blending of wax size with rubber latices as an internal plasticizer in the manufacture of greaseproof papers. This use is quite new and has not been thoroughly evaluated.

The outlook for 1951 is that even larger quantities of wax size will be utilized as an internal waterproofing agent in many grades of paper and paperboard and that new uses will be developed for the application of specially built emulsions to impart surface characteristics.

PLASTICIZERS

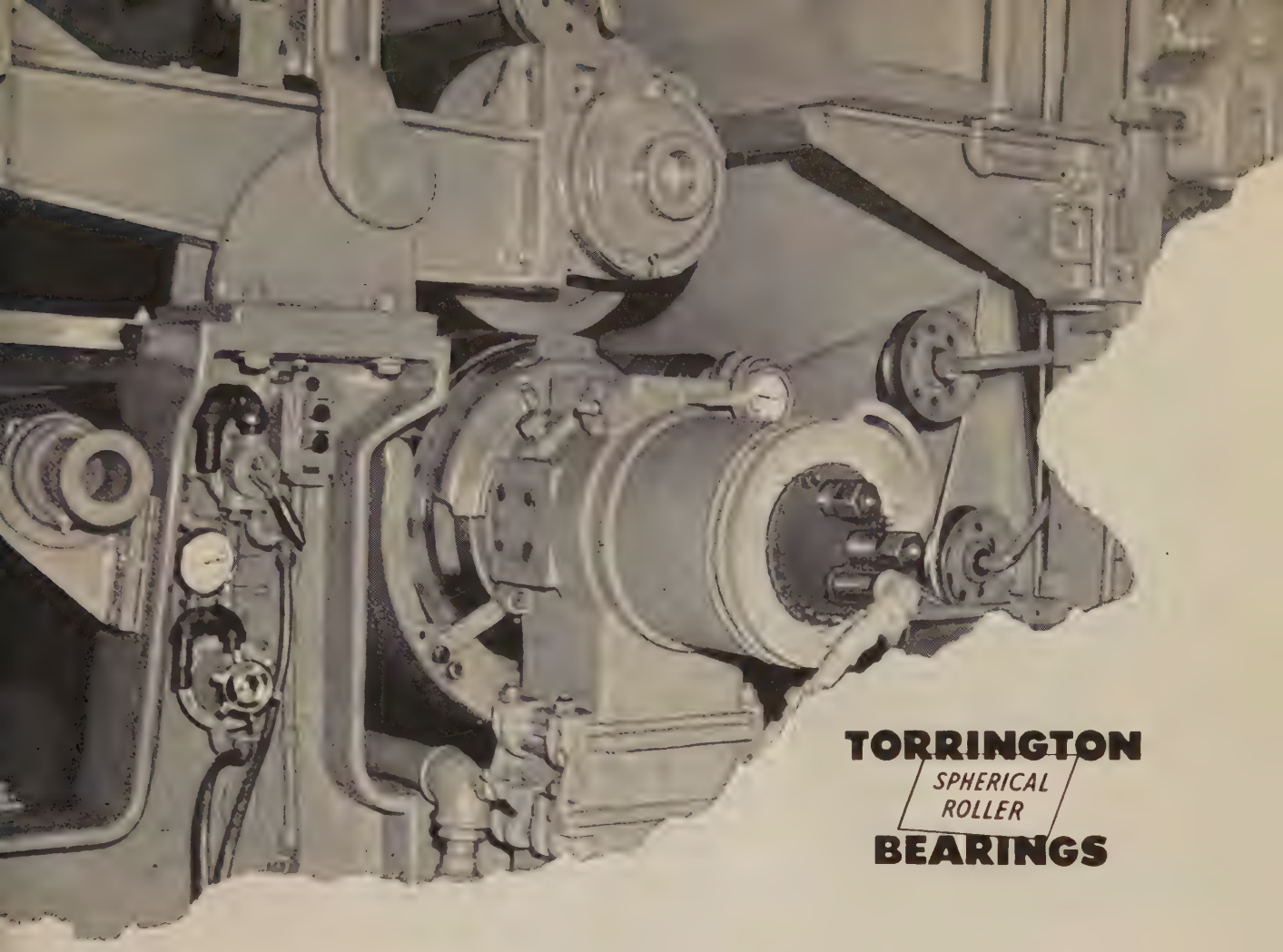
A sharp reversal of the favorable positions reported last year has taken place for plasticizers in general, the only exceptions being the sugars.

All grades of glycerin are in very short supply with refiners forced to allocate deliveries to contract buyers. National Production Authority Regulation No. 1 of Sept. 18, 1950, placed glycerin under inventory control, but this action is not thought likely by the trade to produce any marked improvement in the critical situation. Stocks of crude glycerin are not moving into refiners' hands due to reported asking prices of 70 to 80¢ per pound. Considerable variation is to be noted in refiners' contract prices, with high-gravity glycerin ranging from 44 to 56¢ in car lots. Spot sales of glycerin have been reported as high as $1.35 per pound.

In spite of the wave of sugar buying inspired by the outbreak of the Korean War, which was of near-panic proportions, the producers of invert sugar have kept deliveries moving on regular schedules and at present see no immediate prospects of any curtailment. Current prices range from $8.00 to $8.50 per cwt. drums, f.o.b. works, representing an advance of $0.20 over the same period of 1949.

Corn sugar and syrup are reported to be in good supply with regular deliveries the general rule. This year's corn crop is estimated to be under that of last year but this is largely offset by the largest carry-over in history. Dextrose is currently $6.90 per cwt. in bags, carload, New York and 42° syrup (unmixed) is $5.93 in returnable drums, carload. These prices appear firm with a possible increase predicted for the early months of 1951.

Sorbitol is in very tight supply. New production facilities were completed this fall but have failed to ease



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the situation as yet. Another new plant which will double the capacity of one producer is planned for 1951. Prices have remained steady during 1950 with slight increases taking place on some grades recently. The industrial grade is now $24^1/_4$¢ and the 70% solution $16^1/_4$¢, both drums, carload. One producer is reported to have available for immediate shipment a polyoxane derivative of dextrose which is recommended for plasticizing purposes.

Glycol is extremely tight and being allocated to contract buyers. Use of glycol in electronic equipment has created a terrific demand which will soon be intensified by the defense program. Prices are up slightly; diethylene glycol being currently $19^1/_4$¢ drums, carload and $20^1/_4$¢ l.c.l.

Urea is in very critical supply. The producers are reported to have nothing available for spot purchasers, and deliveries to contract buyers are apt to be delayed. A new producer is expected to enter the field shortly which may help to ease the situation. Contract prices are firm at $4^3/_4$¢, bags, carload for domestic urea, with imported grades ranging from 9¢ up.

BACTERICIDES AND FUNGICIDES

During the past year there has been an increased interest in microorganism control as the mills gear for maximum production and lower operating costs. The demand for special characteristics, such as mold resistance, also has resulted in greater consumption of organism control products.

Prices of bactericides and fungicides will be maintained as long as feasible.

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"Re-examination"
has a special meaning in 1951

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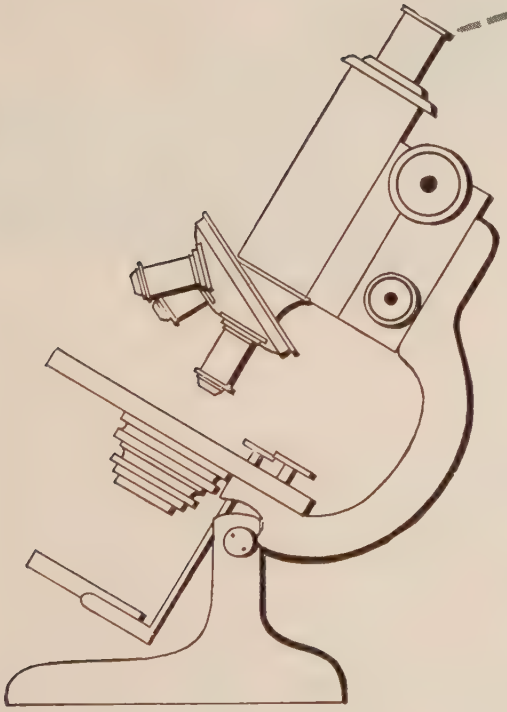

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Quality conscious paper mill superintendents know from experience that chlorination, engineered to their stock or white water requirements by Wallace & Tiernan, effectively eliminates such slime-induced troubles as pin holes, slime spots, and poor sheet formation.

Such results—which have saved up to 400 dollars per day in many mills—are possible because chlorination kills the organisms that *cause* slime. It may be used alone on the fresh water supply, or together with chloramines or other corrective chemicals on the white water, for effective slime control in such key spots as the showers, screens, deckers, and at many other points.

Wallace & Tiernan Chlorinators are particularly effective in slime control work because they are especially designed from over 35 years' experience to give low cost, efficient performance.

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VALUE in a fine product reflects the experience and skills of its makers.

VALUE in Fourdrinier wires is a matter of record . . . paper quality and production records in mills throughout America reflect the fact that *Appleton Wires are Good Wires!*

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wet-strengthen your paper with the UFORMITE resins

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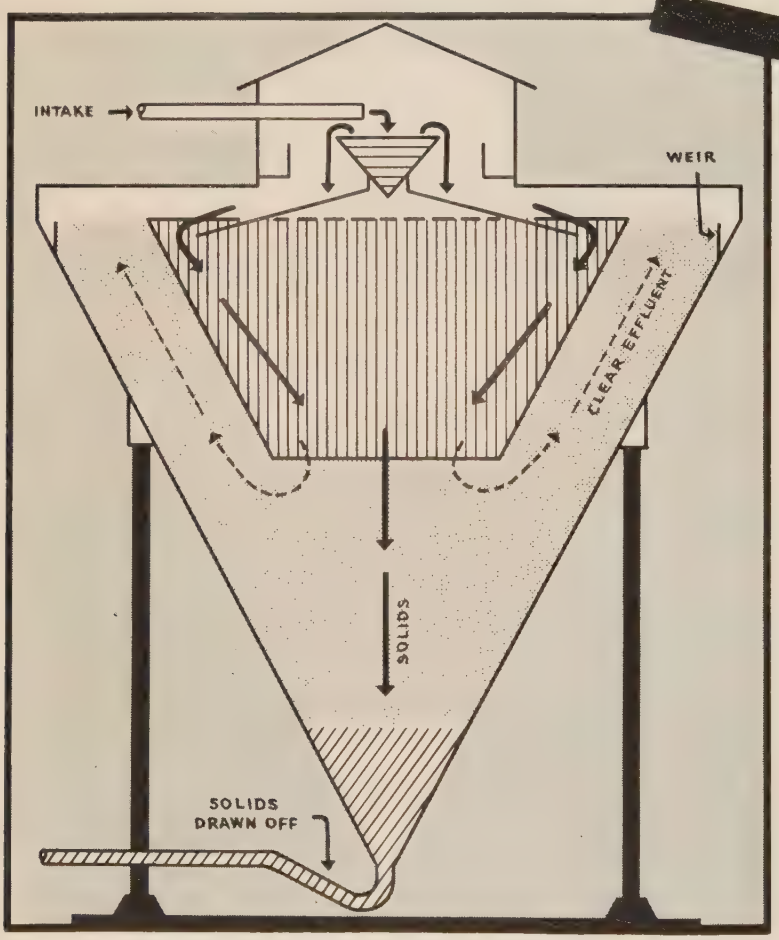
TEXAS PAPERBOARD PLANT CHECKS THE ADVANTAGES OF THEIR MARX SAVEALL

- ✓ Each ton of solids recovered from waste water means an $18.00 saving.
- ✓ Process water can be reused over and over again.
- ✓ All flotation scum is separated for easy disposal into the sewer.
- ✓ The Marx Saveall provides additional water storage capacity.



AT the Dallas, Texas, plant of Fleming & Sons, a Marx Saveall recovered 95 per cent of the fiber carried over from the paperboard making operation in the white water effluent. Approximately 3.3 lbs. of fiber per 1000 gals. that formerly went into the sewers is now saved and transformed into new profits for this paperboard manufacturer.

The thorough, yet economical, process involved requires no chemicals or moving parts. The Marx Saveall consists primarily of two large cones made of plate steel, one mounted inside the other. White water from the paperboard machine is fed into the receiving well at the top of the unit. It overflows on to a deaeration plate, where air bubbles are shaken loose from the solid particles, and runs off into the center of the Saveall. Suspended fibers settle through the inside cone and collect at the bottom of the outside cone. The clear water rises between the two cones and flows over a circular weir into a draw-off channel. The settled solids are drawn off through a pipe at the bottom of the outside cone.

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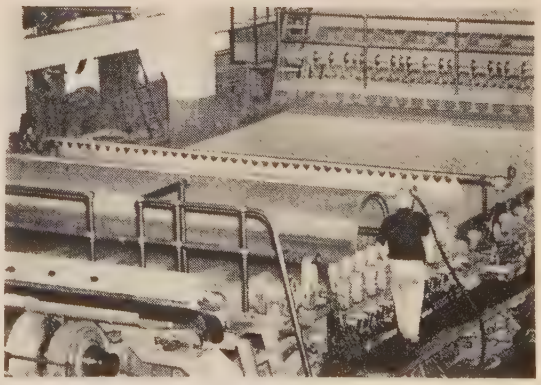
Yes, when you rely upon Nopco's newly-developed KFS to improve processing and manufacturing conditions, it's the "end of the act" so far as foam is concerned... the end of the highly undesirable role it plays in pulp and paper mill. For Nopco KFS is an exceptionally efficient defoamer—able to eliminate obstinate foam conditions within a matter of minutes.

Stable to chemicals such as alum and chlorine, and to hard water, KFS provides extremely effective control at every stage in pulp and paper making where foam needs to be destroyed. For instance: KFS added to effluents from pulp mill and bleach plant cuts foam to negligible proportions—making disposal of waste liquors easy; added to stock in the paper mill, preceding any point where foaming occurs, it prevents foam development—thus assuring better fibre dispersal, reduced breaks, and improved sheet formation.

Nopco KFS is easily made into a stable emulsion by simply agitating with a paddle. Why not order enough for a trial run? You'll find KFS will do a real job of foam elimination, no matter how great the volume or speed of your production.

Send for free bulletin entitled "Nopco KF* Series—Dispersing Agents for Improving Sheet Formation".



AN EFFECTIVE APPLICATION OF NOPCO KFS is seen in this battery of mist-type nozzles set up across the wire. A dilution of 1/10 of 1% KFS is sprayed through the nozzles onto the stock. This prevents foam formation on the wire, and reduces surface tension of water in the stock.

Result: No excessive volume of water falling back from the high speed dandy roll to disturb fibre formation, and no sticking of the sheet to the first bare roll.

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Established 1886

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Plans for 1951 must be evaluated in terms of today's news and tomorrow's potentials and probabilities.

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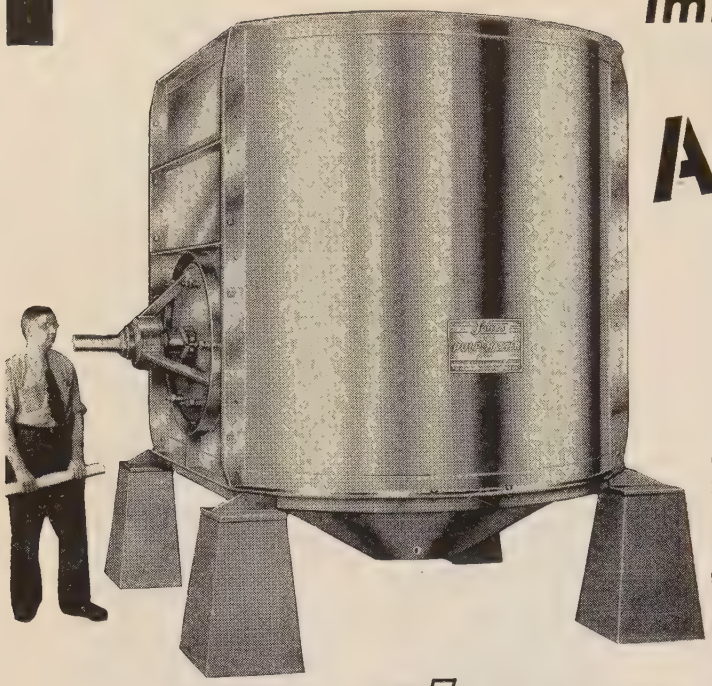
FOR THE PAPER INDUSTRY



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High consistency operation, reduced beating cycles, efficient use of power and low maintenance have been demonstrated in a wide variety of applications.

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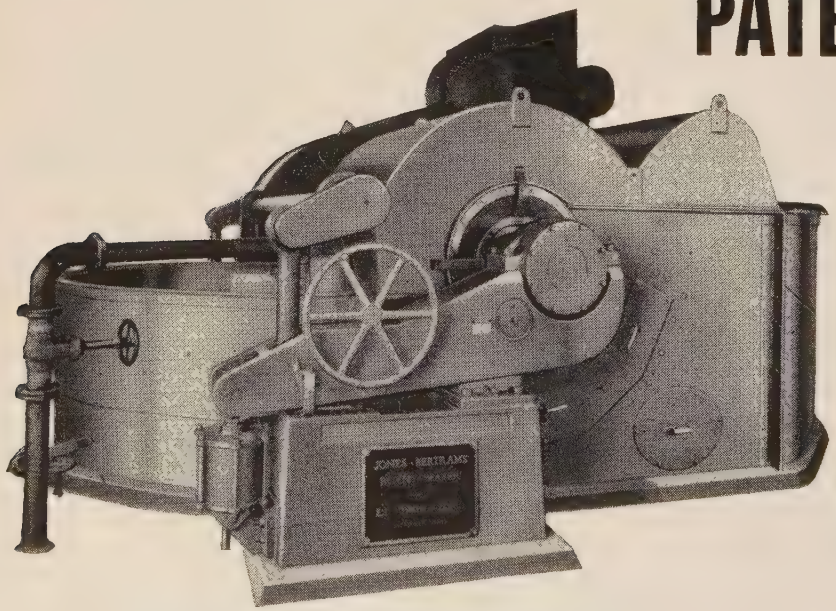

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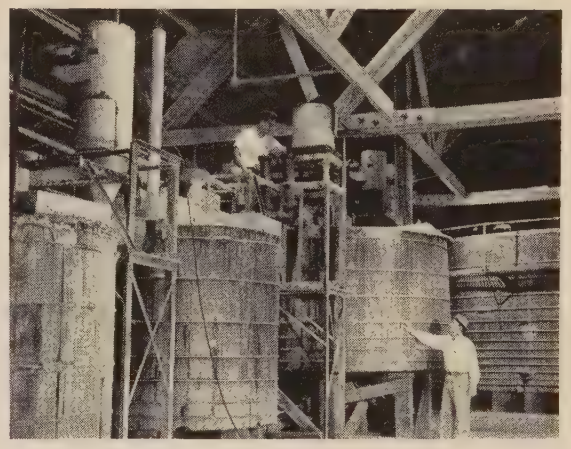
KAOLIN CLAY FACTS . . . *for Paper Makers*

NUMBER 7 OF A SERIES FROM THE J. M. HUBER CORPORATION

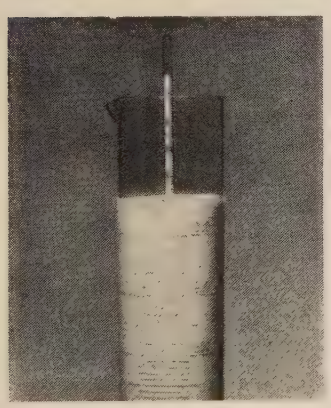
CLAY CONTENT OF PAPERS VARIES WIDELY

Clay content in uncoated papers ranges from 3–35%; generally, however, the average range is from 8–20%. In coated papers the figure depends on the clay content of the base paper, the weight of the coat and the percentage of clay in the coated surface. As a rule, the more dilute suspensions of coating formulations are used in the "brush" or "air-blade" processes, while machine coating requires highly concentrated mixtures. Typical illustrations are indicated in the table below:

Paper Type	Base Paper	Coating	Total Wt. of Paper	Total Wt. of Clay	Clay Sheet
Litho—coated one side	43 lbs/ream—5% clay (2.15 lbs)	17 lbs/ream—85% clay (14.45 lbs)	60 lbs/ream	16.60 lbs/ream	27.7%
Letter Press—Coated both sides	45 lbs/ream—9% clay (4.05 lbs)	12.5 lbs/side—90% pigment of which 75% is clay (8.44 lbs/side)	70 lbs/ream	20.93 lbs/ream	29.9%
Machine Coated Magazine Paper—Coated both sides	39 lbs/ream—11% clay (4.3 lbs)	8 lbs/side—85% clay (6.8 lbs/side)	55 lbs/ream	17.9 lbs/ream	32.6%



Introducing bleaching chemicals into water washed clay slurry at one of Huber's three clay plants.



The Bouyoucas Hydrometer shows the weight in grams of clay in suspension at any given time.

DETERMINING CLAY PARTICLE SIZE

There are various laboratory methods for determining the particle size of clays. All of them depend on sedimentation principles as expressed by a law of physics—Stokes' Law—dealing with the settling rates of small spherical bodies suspended in a fluid medium.

By taking readings of a clay-water mixture at regular intervals with a Bouyoucas hydrometer, the maximum diameter of particles in suspension at any given settling time can be determined from Stokes' Law. The table below is a typical illustration of apparent particle size diameters obtained with a Bouyoucas hydrometer after the time intervals shown at left. As one would expect, the larger, heavier particles settle out rapidly, while the fine, light particles remain in suspension much longer.

Da Values in Particle Size Determination

Settling Time Minutes	Da (Apparent particle diameter) Microns
1	78.42
5	35.07
10	24.80
40	12.40
150	6.40
500	3.50
1500	2.02
3000	1.43
4000	1.24
5000	1.11
6000	1.01
7000	0.94
8000	0.88

Have you received your copy of "Kaolin Clays and Their Industrial Uses"—new Huber 144-page technical reference book? Write on your company letterhead.

PARTICLE SIZE OF HUBER PAPER GRADE CLAYS

	Hi-White Filler	Paragon Filler	Washed Filler	Special Hydratex Coating	Hydratex Coating
Type					
Particle Size (Microns)					
Above 5	12–15%	25–30%	28–32%	3–6%	6–8%
Under 2	63–68%	50–55%	47–52%	78–81%	70–72%

The above tables are condensed from the Huber *Kaolin Clays* book. Complete directions for determining particle size of clays will also be found in this volume.

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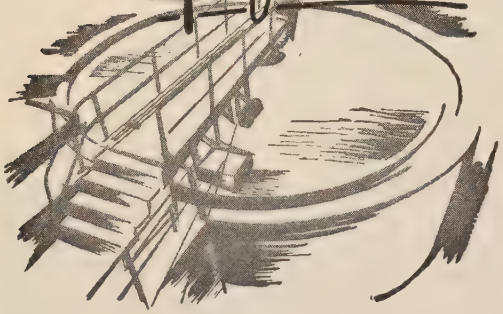

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DORRCO HYDRO-TREATORS

PLANT	JUNCTION CITY, KANSAS	LOCKLAND, OHIO	APPLETON, WISCONSIN	A CANADIAN PAPER CO.	T.V.A., SHEFFIELD, ALABAMA
OPERATION	SOFTENING	SOFTENING	SOFT. COLOR & TURB. REM.	COLOR REM.	ALGAE & COLOR REM.
NO. AND SIZE OF UNITS	2-35′ DIA.	1-31′ DIA.	1-45′ DIA.	2-80′ DIA.	1-50′ DIA.
CAP. PER UNIT, M.G.D.	1.5	1.0	3.1	10.0	3.0
GAL./SQ. FT./MIN.	1.08	.93	1.35	1.34	1.07
AVG. TURB. EFF., PPM	LESS THAN 0.2	5.0	2.4 to 4.7	3 to 5	4 to 7
SLUDGE—% SOLIDS	35 to 46.5	24.9 to 39.2	16.7	—	—

Here are the reasons for this performance...

Uniform Feed Distribution . . . feed is distributed within the sludge blanket by means of rotating arms which constantly agitate the blanket.

Concentration of Sludge Solids . . . sludge solids are collected and concentrated in a central thickening well and are positively removed to avoid the accumulation of a sludge blanket of excessive depth.

Positive Sludge Removal . . . sludge is removed from the entire tank floor positively and continuously by means of rakes attached to the rotating arms.

If you are investigating high-rate, up-flow type units, get *all* the facts before deciding. A Dorr engineer will gladly supply detailed figures and operating results . . . at no obligation.

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National Technical Service provides practical help in your mill on formulas and methods for producing unusual colored papers.

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Abatement of Sulphate Pulp Mill Odor and Effluent Nuisances

W. O. HISEY

The recovery system recently completed and put into operation at the mill of the South African Pulp and Paper Industries, Ltd., is described. This recovery plant was designed and installed with the intention of reducing, to the minimum, the odor and effluent nuisances which are commonly associated with sulphate pulp mill operation. Black liquor oxidation is included in the recovery operation and the oxidation tower is used as a "sulphur trap," in that all waste gases containing malodorous sulphur compounds are diluted with air, passed through the black-liquor oxidation tower, and residual gases from this tower are burned in the recovery furnace. In this way a large proportion of the malodorous sulphur compounds which are normally discharged to the atmosphere are destroyed and their sulphur content is retained in the recovery cycle. Contaminated condensates from the digesters and evaporators are blown with air in a packed tower and the effluent is used as make-up water in a spray-cooling pond. The odor nuisance from this effluent is negligible and the quantity is less than 2000 gallons per ton of pulp produced. Even this small quantity may be reduced or entirely eliminated since the purity is such that it could be reused in the causticizing system, or in pulp washing. Current operating practice is to reuse part of it in the causticizing system. A cyclonic evaporator and a set of fume-recovery towers have been installed following the soda-recovery furnace. Experience to date has indicated that a recovery of more than 90% of the sulphur compounds in the gases leaving the furnace is obtainable in this system. The odor level of the stack gases is very low and is reduced still further by the introduction of a small amount of chlorine. A slight, but distinct "kraft" odor is still evident in the stack gases, although the nuisance so created is hardly more than would be the case with a boiler plant of the same steaming capacity burning a high sulphur content coal. The measures undertaken to eliminate sulphur compounds from the liquid and gaseous effluents have resulted in a high degree of retention of sulphur in the system, with consequent maintenance of sulphidity with relatively low additions of make-up chemical.

THE sulphate pulping industry has undergone rapid development since its inception some 80 years ago and, from a standpoint of production capacity, is now the most important of the chemical pulping processes. This rapid development has taken place in spite of the major difficulty presented by the malodorous and toxic waste products which are discharged into the atmosphere and streams by the typical sulphate pulp mill. Problems resulting from these waste products have been especially severe for mills which have been located in urban areas or on watercourses with low or intermittent flow, and numerous sulphate pulp mills have been in difficulty over stream or atmospheric pollution. Since it appears that the laws against such pollution will probably be made more stringent and their enforcement more rigorous in the future, the problem brought on by such pollution becomes an important one facing the industry.

Furthermore, the discharge of sulphur compounds which give rise to atmospheric and stream pollution represents an important technical and economic loss to the industry. Hägglund (*4*) presents evidence that high sulphidity in the cooking liquor results in a high rate of dissolution of lignin and improved pulp properties. In the normal systems of alkaline recovery, the loss of sulphur tends to be high relative to the loss of sodium so that a mill which is efficiently operated, with respect to the recovery of sodium compounds, is prone to suffer from the effects of low sulphidity (*2*) unless special steps are taken to replace sulphur without also introducing additional sodium. Salt cake, to replace the lost sodium and sulphur, is not so inexpensive as formerly and the addition of 200 to 300 pounds for every ton of pulp produced represents a substantial item of cost.

The mill of the South African Pulp and Paper Industries Ltd., located at Springs, near Johannesburg, South Africa, was started in 1938 to use the Pomilio process on straw. Technical and economic difficulties were experienced in the operation of the process and the mill was converted to the manufacture of pulp from wattle, eucalyptus, and pine timbers, by the soda process. The soda recovery system originally installed soon proved to be inadequate to deal with the liquors arising from increased pulp production and the decision to replace it with a modern type of soda recovery system presented an opportunity to change over to the sulphate process and thus obtain optimum pulp qualities from locally available timber supplies.

Difficulties inherent in placing a sulphate pulp mill on the existing site were formidable. The mill is located in the midst of the Witwatersrand gold-mining area, within 2 miles of the center of the City of Springs. At least 100,000 persons live within a radius of 5 miles of the mill, and the community depends primarily on operation of gold mines for its livelihood. In fact, S. A. Pulp was the first large industry in the area, so the people there are not accustomed to tolerating industrial odors. The water and effluent problems are also difficult, since water supplies are strictly limited, and a large part of the water supply for the mill arises from deep level mining operations. There is no river in which the effluent can be "lost" since the only stream available is one which flows intermittently, following heavy rains.

An investigation was made of proposed methods of odor control in the sulphate pulping industry, as well as other industries. Mills were visited in the United

W. O. HISEY, Member TAPPI; Consulting Engineer, Union Corporation Ltd., Johannesburg, South Africa.

States, Canada, Sweden, and Australia, and the problem was discussed with numerous interested persons. Tomlinson (*7*) had recently announced his system for black-liquor oxidation and secondary chemical recovery, and special attention was devoted to this system as it was being developed at Cornwall, Ont., and Windsor Mills, Que. As a result of this investigation it was concluded that the Tomlinson system provided a mechanism through which odor control could be achieved.

Permission to use the patents in South Africa was obtained, and a system was designed with the hope that it would result in substantial elimination of noxious odor and effluents as well as give good efficiency of chemical recovery and retention of high sulphidity in the digestion liquors. Effluent liquids and gases are collected at their sources, subjected to oxidation and absorption processes, with return of the chemical values to the system. Escape of contaminated liquid effluents and waste gases are each confined to a single point, thus simplifying and centralizing control. It is the purpose of this paper to describe some of the features of this system and to report on the results which have been obtained during the months which it has been in operation.

NONCONDENSABLE GASES FROM THE DIGESTERS

Gases arising from the relieving and blowing of digesters are normally a serious source of atmospheric contamination because of their high content of sulphur compounds. Such gases arising from the kraft digestion of hardwood timbers appear to be worse in this regard than those from the digestion of softwoods. Reid (*5*, *6*) has investigated the gases liberated during the digestion of eucalyptus in Australia and has come to the conclusion that both the quantity and noxious quality of such gases are greater than are commonly associated with the digestion of softwoods. He has identified isopropyl mercaptan and di-isopropyl disulphide in the relief gases from the sulphate digestion of *E. regnans*, and has recovered as much as $^1/_4$ gallon of an oily condensate consisting primarily of the latter compound from the blowing of a 2000-cubic foot digester. This compound is said to be extremely odorous, and the oily condensate mentioned requires to be diluted to 1 part in 20 million to reduce the odor to a barely detectable level. The unusual quantity of noncondensable gases from the digestion of wattle and eucalyptus has also been noticed at Springs, and it has been found necessary to use a continuous relief to avoid the development of "false" pressures in the digesters. Such gases are very rich in sulphur compounds, and analyses of the relief gases from the digesters at Springs have given results of between 4000 and 5000 pounds of sulphur per million cubic feet of gas. Such large quantities of sulphur indicate these gases to contain upward of 70% by volume of organic sulphur compounds. Such gases are highly combustible when mixed with air (*6*), and care is necessary to eliminate the accumulation of an explosive mixture in the system.

Consideration was given to several alternative methods of handling these relief gases, and the method finally chosen was to pass them into the blow tank and condenser system. Choice of this method was predicated on the continuous digester relief already mentioned, since such relief provides a continuous steam purge of the blow tank, which is under a constant back pressure, and thus prevents the inflow of air. This exclusion of air from the blow tank prevents the creation of an explosive mixture, and noncondensable gases which pass through the blow condenser are immediately diluted to a concentration far below the minimum explosive limit. A hazardous condition might develop in the blow tank during periods of partial or complete plant shutdown, when absence of digester relief might allow the admission of air to the system. Operating and maintenance men are aware of this potential hazard, and the system is thoroughly purged at every shutdown period.

A better arrangement might be to lead the digester relief gases directly to the black-liquor oxidation tower, without dilution. However, it is known that iron sulphide is an excellent catalyst for the oxidation of mercaptans, and cases have been reported of combustion taking place within such a pipe line. If this arrangement is used, it would appear to be necessary to purge the blow tank continuously with air to eliminate the possibility of the development of an explosive mixture.

Several methods are available for the condensation of vapors arising from the blowing of digesters, and the recovery of the heat in the form of hot water for pulp washing. In the present case, a surface condenser has been used since with this apparatus both the foul condensate and the noncondensable gases could be confined for further treatment. This surface condenser has some 6000 square feet of heating surface and has proved to be adequate for the condensation of all steam arising from the blowing of digesters of 2000-cubic feet capacity. Condensate arising from the blow is piped to the contaminated water system, described below. Noncondensable gases from the blow condenser are immediately diluted with air to a very low concentration (Table II) and are passed through a duct to the black-liquor tower. The air used in this dilution is the exhaust from the vacuum pumps used on the pulp washers, which thus serves as one source of oxygen for the black-liquor oxidation, as well as dilution for the potentially combustible gases from the digesters. All odors arising from the digesters and washers are thus confined to a closed system. In addition to sulphur compounds, both the condensate and the noncondensable gases from the digesters appear to contain substantial quantities of ammonia, apparently arising from nitrogen compounds contained in the wood.

OXIDATION OF BLACK LIQUOR

Several studies of the oxidation of black liquor with air prior to evaporation have been published in recent years, and these studies as well as experience in several mills, have shown that such oxidation results in the conversion of a large portion of the volatile sulphur compounds in the black liquor to nonvolatile forms. The full implications of this oxidation reaction are not fully understood, but it appears that the liberation of sulphur compounds in the evaporators is greatly reduced and the black liquors are less corrosive.

Bergstrom and Trobeck (*8*) have used a process in which the black liquor is completely converted to foam. Tomlinson (*7*) uses a packed tower, although troubles

due to foam and plugging of the tower with fiber and soaps have been reported. Sulphate black liquors take up oxygen with great avidity, so that any process by which adequate supplies of oxygen are brought into intimate contact with the black liquor would appear to give a reasonably satisfactory result. In the present case a packed tower was chosen on account of its simplicity, the packing being a four-cell hollow tile of a type commonly used for building purposes. This packing has the virtue of providing adequate channels for the flow of liquid and air, and film-type flow over the flat surfaces minimizes foam formation. No difficulty due to foam or plugging has been found during 6 months of continuous operation.

Routine determinations of the degree of oxidation have been made since the initial operation of the tower, using the TAPPI method involving distillation from a solution containing ammonium chloride. In general, the results have indicated approximately 85% oxidation, a few typical results being given in Table I. Column III

Table I. Typical Results from Black-Liquor Oxidation Tower

	I	*II*	*III*
Sulphidity of smelt, %	14	18.7	25.5
Na_2S in black liquor entering oxidation tower, g./l.	3.4	5.4	8.2
Na_2S in black liquor leaving oxidation tower, g./l.	0.58	0.45	1.28
Oxidation efficiency of tower, %	83	92	84
Further oxidation of black liquor from tower			
Na_2S after treatment with air for 20 hours, g./l.	...	...	0.66
After 48 hours, g./l.	...	...	0.53

of this table includes also some results obtained in an attempt to carry the oxidation to a further degree than was possible in the tower, with its limited time of contact. It is to be noted that even a further 48 hours of treatment with air failed to completely eliminate the volatile sulphur. These and other similar results indicate that two separate reactions are involved in the process, the first, rapid reaction probably involving only the —SH group, while the second, slow reaction may well involve sulphur which is loosely bound to an organic complex. Further investigation of these oxidation reactions may well prove to be a fruitful field for research.

In practice, the degree of oxidation achieved has been sufficient to prevent any obvious corrosion of mild-steel evaporator tubes and other mild-steel equipment in the evaporator section. Noncondensable gases from the evaporators contain a relatively high concentration of sulphur compounds (Table II) which may arise from the decomposition of organic sulphur compounds. A longer period of operation will be required to determine whether corrosion at the evaporators is going to be a serious problem or not.

The black-liquor oxidation tower is used as a trap for sulphur compounds in the gases arising from the digesters and evaporators. Ducting is arranged so that all malodorous gases are passed through the oxidation tower, providing an opportunity for sulphur compounds to be oxidized and absorbed, and thus returned to the system. To date it has not proved possible to establish a sufficiently accurate balance over the system to determine the extent of such absorption, although it would appear to be appreciable. Gases vented from the black-liquor oxidation tower contain considerable quantities of mercaptans and disulphides (Table II), which would make

Table II. Sulphur Compounds in Gas Streams

(Pounds Sulphur Per Million Cubic Feet Gas)

	H_2S and mercaptans	*Organic disulphides*	*Inorganic sulphur*	*Total sulphur*
Digester relief gases to black-liquor oxidation tower—after dilution	1.78	2.40	Nil	4.18
Noncondensable gases from evaporators	575.9	99.2	Nil	675.1
Gases leaving black-liquor oxidation tower—entering forced draft fan	3.55	7.42	Nil	10.97
Estimated quantity sulphur returned to furnace from black-liquor oxidation tower as pounds Na_2SO_4 per ton pulp	...	...	...	8.3

Operating conditions: sulphidity—14% black liquor entering oxidation tower—5.2 g./l. Na_2S, black liquor leaving oxidation tower—0.85; and oxidation efficiency—84%.

them very obnoxious if they were vented to the atmosphere. Tests on these gases have indicated that the sulphur compounds are so highly diluted with air as to constitute no possible explosion hazard, so they are now led to the suction side of the forced draft fan, and thus returned to the furnace. There was some question, at first, as to whether the irregular flow of these gases, due to the blowing of the digesters, and possible irregularities of composition, might interfere with the operation of the furnace, but no such difficulties have been experienced in practice. The return of these gases to the furnace, where they are burned and the sulphur content retained in the system, is undoubtedly an important factor in reducing the odor nuisance to a low level. The change was most noticeable when this practice was first adopted.

EVAPORATOR ARRANGEMENTS

In the normal sulphate mill, the evaporators take second place only to the digesters as sources of atmospheric and stream pollution. Fixation of sulphur compounds by oxidation of the black liquor greatly reduces this nuisance, but does not entirely eliminate it. The usual barometric jet condenser for vapors from the evaporators was not suitable for the conditions at Springs due to the inadequacy of water supplies and to the effluent problem involved. A surface condenser, with stainless-steel tubes, is used and thus the cooling water is positively separated from the contaminated condensate and the noncondensable gases, which are available in concentrated form for further treatment. Heat absorbed in the condenser cooling water is dissipated in a spray pond, and the water is recirculated to the condenser. The water requirements of the spray pond are very small, and the effluent problem created by a barometric jet condenser is eliminated.

Noncondensable gases from the evaporators are evacuated by a steam-jet ejector, and are introduced into the black-liquor oxidation tower, whence they are eventually returned to the furnace and burned. Contaminated condensate is mixed with the condensate

from the digester blow system, and is treated in the contaminated water system, described below.

CONTAMINATED WATER SYSTEM

The foul condensates from the digester blow and the evaporators are circulated through a packed tower, similar to the black-liquor oxidation tower. Air is blown through this tower to oxidize or strip volatile sulphur compounds in these condensates. The foul gas from the top of the contaminated water tower is used as an air supply for the black-liquor oxidation tower, thus preventing the malodorous substances from reaching the atmosphere. The liquid effluent from the contaminated water system amounts to approximately 1800 gallons (U. S.) per ton of pulp, and has a perceptible, but not strong, "kraft" odor. A typical analysis of this effluent is given in Table III. Present operating

Table III. Contaminated Condensate Effluent

pH	10.5
Total solids, g./l.	0.384
Na_2SO_4	0.047
Na_2SO_3	Nil
$Na_2S_2O_3$	0.252
Na_2S and mercaptans	0.019
NaCl	0.028
Organic and undetermined	0.038
B.O.D.—30 hours, p.p.m.	930
Rate of flow, U. S. gallons per ton pulp	1800
Equivalent Na_2SO_4 lost per ton pulp, lb.	4.6

practice is to add a small amount of chlorine to this effluent, to reduce the odor, and to use it as make-up in the spray pond previously mentioned. A spray is an excellent device for the liberation of odors, and the fact that this effluent is used as the only make-up for the spray pond, without creating a nuisance, is excellent evidence of the low odor level of the effluent. It is to be noted that this represents the sole process effluent from the entire unbleached pulp system, up to the screens. Normally, this effluent is of sufficient degree of purity to be used in the causticizing system, and for pulp washing, in which case it could all be absorbed in the system. Currently, this effluent is being used in the causticizing system, and it is planned that the balance will be returned for pulp washing in the near future. In this case, the sole liquid effluent from the digesters, pulp washers, soda-recovery, and causticizing systems will be floor washings, spillages, and the liquid included in lime mud, no lime reburning being practiced.

SECONDARY RECOVERY SYSTEM

The soda-recovery furnace in use is a standard design B & W-Tomlinson furnace with a nominal capacity for 75 ton of pulp daily, and it is now being operated at approximately its rated capacity. A secondary recovery system, including a cyclonic evaporator and three fume recovery towers, has been installed to obtain a high recovery of sodium and sulphur compounds and eliminate the fume nuisance which is created by many sulphate mills.

Hot gases from the boiler enter the cyclonic evaporator at 400 to 450°F. and are cooled to an exit temperature of 190 to 220°F. This represents a substantial evaporation of water from the heavy black liquor which normally enters the cyclonic evaporator from the multiple effect evaporators at 51 to 53% solids, and leaves at 62 to 65% solids. Direct contact evaporators, disk or cyclonic, have been held to increase the odor of the stack gases through displacement of hydrogen sulphide by carbon dioxide (*1, 2, 3*). This may well be true under certain operating conditions, and the data of Table IV show one case, with high operating sulphidity, in which the content of H_2S and mercaptans in the gas stream leaving the cyclonic evaporator is higher than that in incoming gas stream. In both of the other cases cited in Table IV, with lower operating sulphidity, the content of H_2S and mercaptans is substantially reduced in the cyclonic evaporator.

The results of three sets of tests on the cyclonic evaporator, made at different times and under rather widely varying operating conditions, are included in Table IV. The outstanding feature of these data is the fact that the recovery of sulphur compounds is shown to be considerable. Individual components of the gas streams entering and leaving the evaporator vary widely under the different operating conditions, but the over-all recovery of sulphur compounds appears to be good, varying from 48 to 126 pounds of sodium sulphate per ton of pulp. The presence of sodium chloride in the gases is to be attributed to salt introduced with electrolytic caustic soda which was used for alkali make-up.

Table IV. Cyclonic Evaporator Operating Tests

	Entering cyclonic evaporator			*Leaving cyclonic evaporator*		
	I	*II*	*III*	*I*	*II*	*III*
Gas temperature, °F.	420	440	400	...	189	195
Gas dew point, °F.	...	...	...	...	169	170
Black liquor concentration % solids	51.5	54.0	54.7	62.5	65.6	64.1
Smelt sulphidity during test period, %	19	25	14	...	...	...
Gas analyses, equivalent lb. Na_2SO_4/ton pulp						
H_2S and mercaptans	17.4	2.6	52.5	9.1	10.6	19.0
Organic disulphides	ND	ND	3.2	ND	ND	1.9
COS and CS_2	1.2	0.8	Nil	0.9	0.8	Nil
Sulphur dioxide	58.0	10.0	5.3	5.5	2.0	Nil
Sulphur trioxide	Nil	Nil	Nil	Nil	Nil	Nil
Sodium thiosulphate	Nil	Nil	Nil	18.8	6.0	Nil
Sodium sulphate	153.0	136.0	234.5	86.0	82.0	148.0
Sodium carbonate	34.8	Nil	5.4	11.4	Nil	2.9
Sodium chloride	38.1	30.0	74.3	20.8	Nil	27.3
Total sulphur compounds in gas, lb. Na_2SO_4/ton pulp	229.6	149.4	295.5	120.3	101.4	168.9
Salt cake recovery in cyclonic evaporator, lb. Na_2SO_4/ton pulp	...	...	...	109.3	48.0	126.6
Furnace gases: CO_2, %	14.2	12.6	12.9	...	...	...
O_2, %	4.6	7.0	5.5	...	...	...
CO, %	Nil	Nil	Nil	...	...	...

Gases leaving the cyclonic evaporator pass to the induced draft fan and are blown through the fume recovery system before entering the separator and stack. The fume recovery system consists of three towers, through which the gases pass in series, each tower being equipped with a central spray header and 280 spray nozzles. Liquor is recirculated in each tower at 1800 gallons (U. S.) per minute, the concentrated fume solution being bled from the tower system at approximately 10% solids and introduced into the weak black liquor at the oxidation tower. During the early operation of the fume-recovery system the efficiency of recovery was very poor, and the amount of fume discharged to the atmosphere was excessive. In fact, at this stage, the plume of fume extended for well over a mile from the mill. This condition was corrected by replacing all spray nozzles with an improved type, giving good atomization, and by the introduction of baffles in the gas ducts between the spray towers to produce high gas velocities and pressure drops at the gas inlets. With these changes, the gas temperatures in the spray towers reached saturation, and in fact a considerable amount of condensation takes place in the towers. Under these conditions, the recovery of chemicals in the tower system is excellent, 90% or better, and the plume of fume has substantially disappeared. Table V includes the results of two sets of tests on this

Table V. Fume-Recovery System Operating Tests

	Entering fume-recovery system from cyclonic evaporator		*Leaving fume-recovery system to stack*	
	I	*II*	*I*	*II*
Gas temperature, °F.	195	193	157	154
Gas dew point, °F.	170	157	156	153
Smelt sulphidity during test period, %	14	16.5	...	...
Gas analyses, equivalent lb. Na_2SO_4/ton pulp				
H_2S and mercaptans	19.0	8.8	2.8	0.5
Organic disulphides	1.9	Present	2.0	Present
COS and CS_2	Nil	2.7	Nil	1.6
Sulphur dioxide	Nil	8.9	Nil	Nil
Sulphur trioxide	Nil	Nil	Nil	Nil
Sodium thiosulphate	Nil	14.1	Nil	3.5
Sodium sulphate	148.0	124.0	12.5	4.0
Sodium carbonate	2.9	Nil	2.2	2.0
Sodium chloride	27.3	14.7	8.5	8.9
Total sulphur compounds in gas lb. Na_2SO_4/ton pulp	168.9	158.5	17.3	9.6
Salt cake recovery in fume system, lb. Na_2SO_4/ton pulp	...	...	151.6	148.9

system, and in both cases the recovery of salt cake per ton of pulp is shown to be of the order of 150 pounds per ton of pulp, while net losses in the fume are of the order of 10 to 20 pounds of salt cake per ton of pulp. The photograph, Fig. 1, shows the discharge from the stack under conditions of good recovery. The discharge from the stack is saturated vapor, the moisture evaporating within a few yards in the dry air of the Transvaal, leaving an almost undetectable residue of fume.

The data of Table V indicate that small quantities of mercaptans and disulphides are still present in the stack gases, hardly sufficient to be distressing but definitely detectable. The stack, which is of steel, has been lined with Gunite and treated with a rubber compound as a protection against corrosion, and current operating practice is to add a small amount of chlorine to the saturated vapor in the stack. This chlorine, amounting to 4 or 5 pounds per ton of pulp, reacts rapidly in the warm saturated atmosphere of the stack, and appears to deodorize the mercaptans, but apparently does not react with the disulphides, which are themselves the products of oxidation of mercaptans. The residual stack odor thus appears to be due to the presence of disulphides which pass through the fume-recovery system substantially unchanged. This residual odor is relatively slight, and, although truly "kraft" in character, is hardly more of a nuisance than the stack gases from a boiler plant burning a high sulphur coal.

Fig. 1. View of stack showing limited fume discharge

During the early operation of the fume-recovery system, some difficulty was experienced with corrosion in the fume-recovery towers. Such corrosion was serious in the spray nozzles and pump impellers, parts which were of cast iron and were subjected to the erosive action of high-velocity liquors. At that time high sulphidity was being maintained (over 30% at one stage), and the recovered fume solution became very acid, in spite of the fact that considerable quantities of caustic soda were added in an attempt to maintain alkaline conditions in the fume towers. Sulphidity is now being maintained at a much lower figure (18 to 20%), recovered fume solution remains alkaline, and no further evidence of corrosion has been noted. Furthermore, during the early operation of the system, alkali make-up was by the addition of electrolytic caustic soda which contained substantial quantities of sodium chloride and somewhat more than traces of sodium chlorate. This resulted in the introduction of chlorine compounds which accumulated in the system, as may be seen in the data of Tables IV and V, and which may also have contributed to corrosion in the fume-recovery system. At the same time, sulphidity was being built up through the introduction of sulphur to the digesters, and this may also have resulted in active sulphur compounds in the stack gases and thus contributed to the corrosion. At present make-up is by the use of salt cake, in the normal manner, but a considerable period of operation will be required to determine

whether the corrosion was primarily due to the high sulphidity, to active chlorine compounds, or to the use of sulphur in the digesters.

SUMMARY

The soda-recovery system herein described may be fairly said to have accomplished the following results:

1. Quantity and pollutional quality of the effluents from the unbleached pulp, soda recovery, and causticizing systems have been reduced to a sufficiently low level that it would not be objectionable even in a very small stream. The quality of this effluent is sufficiently good so that it may be entirely absorbed in the system, as warm water for pulp washing, and in the causticizing system, thus eliminating stream pollution from this source.

2. The odorous characteristic of the effluent gases has been greatly reduced, although not entirely eliminated. Stack gases still contain a small amount of disulphides which are detectable, but not obnoxious. If a practical method can be devised for dealing with these compounds, a truly odorless sulphate mill will result.

3. As a result of the steps which have been taken to prevent the escape of sulphur compounds, they have been retained in the system, and make-up chemical required has been relatively small. Sulphidity of the order of 18% has been maintained by the addition of sulphur equivalent to approximately 100 pounds of salt cake per ton of pulp produced, and it is anticipated that sulphidity of the order of 25% should not require more than 150 pounds salt cake per ton of pulp. Additional operating experience will be necessary to confirm these figures, but experience to date indicates that they are reasonable expectations.

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Hydrogenation of Douglas-Fir Lignin

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Lignin residue from the hydrolysis of Douglas-fir sawmill waste was hydrogenated in batch equipment at the U. S. Forest Products Laboratory at a temperature of 320°C. in the presence of copper chromite and Raney nickel catalysts. Decalin was used as a suspending medium. The product, on the basis of the lignin, was a complex mixture composed of 26.3% neutral oils, 3.8% low-boiling acids and phenols, 1.2% water-soluble materials, 7.3% low-boiling tars, 11.6% pitch, 29.3% unreacted residue, 4.8% water, and 15.7% gas and unaccounted-for products.

The lignin used for hydrogenation was the unpurified residue from the hydrolysis of Douglas-fir mill waste (*5*) containing 30% bark. It contained material of which 83.2% was insoluble in 72% sulphuric acid (*15*), 6.5% was soluble in alcohol-benzene, 2.3% was soluble in water, and 8% consisted of nonlignin materials, chiefly cellulose. The alcohol-benzene-soluble fraction (*3*) included long-chain aliphatic hydrocarbons, alcohols, and acids. Lignins produced by acid hydrolysis of wood have been shown to contain highly polymerized molecules (*4*) that were practically insoluble in ordinary solvents.

HYDROGENATION OF LIGNIN

Hydrogenation was carried out in an electrically heated 2-liter nickel-steel pressure cylinder arranged to rock in a vertical plane. A series of runs was made, in each of which 200 grams of air-dried lignin residue plus 2 grams of calcium oxide and the catalysts were suspended in 850 ml. of decalin. Five of these runs are shown in Fig. 1. The decalin for four of the runs was fresh. In the fifth run, B, which was identical with run A in other respects, the lignin was suspended in decalin recovered from previous runs. The recovered decalin appeared to contain inhibitors. The calcium oxide was added to promote the hydrogenation of phenols (*16*). Commercial hydrogen was introduced at a pressure of 3500 p.s.i. by means of a booster pump, and shaking was then begun. After the pressure became constant, a pressure reading was taken, and heat was turned on. About $1^1/_2$ hours were required to raise the temperature to 320°C., after which the temperature was maintained at 320°C. for 4 to 5 hours. During the heating, pressure rose to a maximum of 5500 p.s.i. and then fell, due to the absorption of hydrogen, to 2300. The cylinder was then allowed to cool to room temperature overnight, while the pressure fell to about 500 pounds. A total of 4655 grams of lignin residue was hydrogenated. The hydrogen absorbed averaged 1 mole of hydrogen for 32.5 grams of lignin.

FRACTIONATION OF PRODUCTS

The product was first separated into benzene-soluble and benzene-insoluble products, and the benzene-soluble material was further fractionated as shown in Fig. 2. Separation of pure compounds was difficult because of the complex mixture of products present. Because some of the products were mutually soluble, separation

Ira T. Clark, Chemist, James R. Hicks, Chemist, and Elwin E. Harris, Chemist Specialist, Forest Products Laboratory, maintained at Madison, Wis., in cooperation with the University of Wisconsin, Forest Service, U. S. Department of Agriculture. This paper was presented to American Chemical Society Sept. 6, 1950, Chicago, Ill.

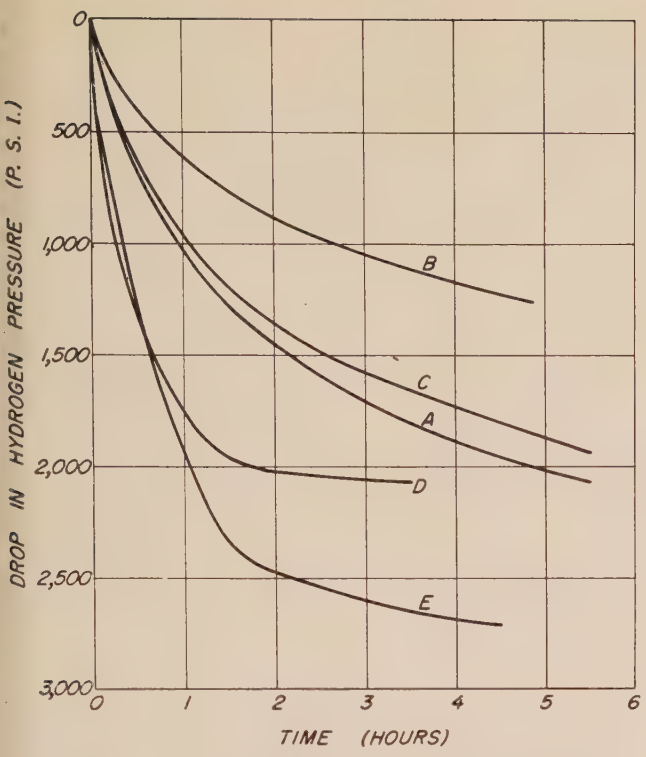

Fig. 1. Hydrogenation of Douglas-fir lignin

Run	°C.	$CuCr_2O_4$/lignin	Raney nickel/lignin
A	300	0.1	0.0025
B	300	0.1	0.0025 (in reused decalin)
C	300	0.2	0.01
D	350	0.2	0.01
E	350	0.2	0.05

by chemical means was difficult. Other products formed constant-boiling mixtures, and still others were oxidized or polymerized during the process of separation.

The benzene layer was separated from aqueous products and subjected to fractional distillation, first under atmospheric and then under reduced pressure. The high-boiling residue was rehydrogenated at 350°C. and again distilled under a pressure of 1 mm. of mercury (Hg). Volatile products were combined. Nondistillable residue was 541 grams. The combined volatile products were fractionated into three fractions in a 5-foot Fenske column that had a 25-mm. inside diameter and that was packed with glass helices. The fractions obtained were as follows: (I) that boiling below 120°C. at 100 mm.; (II) that boiling from 120 to 140°C. at 100 mm. (this fraction included decalin); and (III) that boiling from 150°C. at 100 mm. to 350°C. at 1 mm. Each of the fractions was extracted with 5% aqueous sodium hydroxide to remove water-soluble and alkali-soluble products. Phenolic substances were recovered by treating the solution with carbon dioxide and extracting the solution with ethyl ether. The water-soluble organic acids were recovered from the solution by acidifying it with dilute sulphuric acid and by extracting them with ethyl ether.

WATER-SOLUBLE PRODUCTS

Water-soluble organic products representing 1.2% of the lignin were separated from the water washings into neutral oils, phenols, acids, amines, and nondistillables by the procedure shown in Fig. 3.

Cyclohexanol was isolated from the water-soluble neutral products by fractional distillation. It was identified by the formation of a 3,5-dinitrobenzoate that melted at 111°C.

Phenol was isolated from the phenolic fraction and identified by its 3,5-dinitrobenzoate derivative that melted at 145°C.

Acetic acid was obtained by distillation of the acidic fraction. It was identified by its boiling point (114 to 116.5°C.), its neutral equivalent (59.2), and its anilide derivative (melting point, 112°C.).

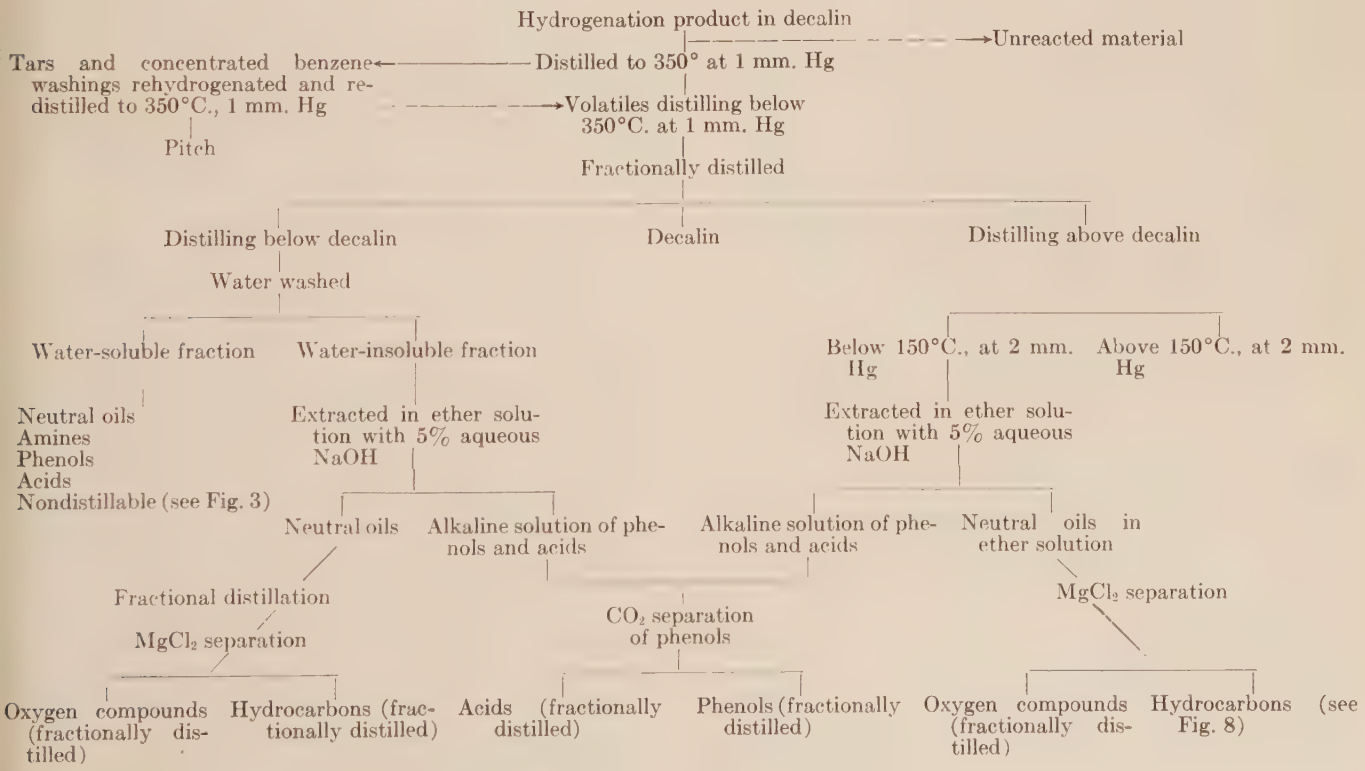

Fig. 2. Separation of hydrogenation products

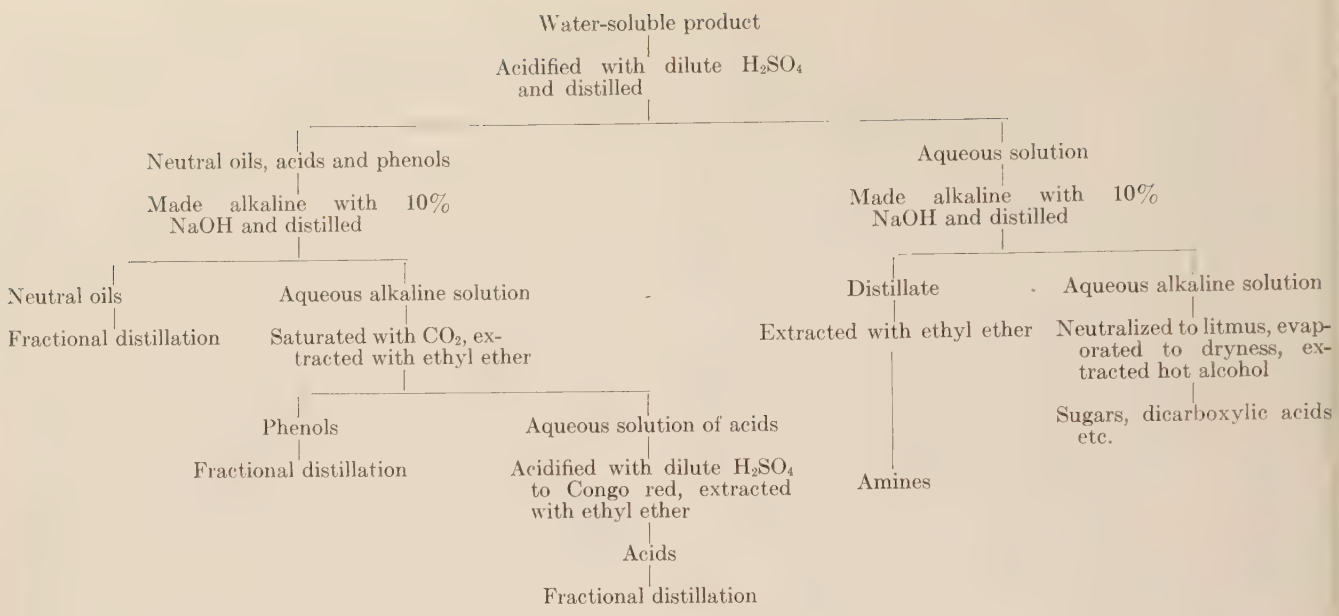

Fig. 3. Separation of water-soluble products

The amine and nondistillable products were not of sufficient quantity for fractionation or identification. The amine fraction had the odor of ethylamine. The nondistillable material was an acidic sirup that would not form an osazone or anilide.

WATER-INSOLUBLE NEUTRAL OILS

Neutral oils with three different boiling ranges, as shown in Fig. 2, were separated from the lignin-hydrogenation products. The neutral oils boiling below 184°C. were distilled at a 20:1 reflux ratio in a column having the efficiency of 98 theoretical plates. The distillation curve is shown in Fig. 4. Except for a cyclohexane-benzene plateau at 77 to 80°C., the fractionation indicated no pure compounds. For this reason the neutral oils were treated with anhydrous magnesium chloride (*6*, *11*, *12*) to remove neutral oxygen-containing compounds. The hydrocarbons recovered from the treatment were distilled. Figure 5 shows the distillation curve. Cyclohexane, methylcyclohexane, ethylcyclohexane, propylcyclohexane, and toluene were identified in the hydrocarbon fraction.

The neutral-oil fraction boiling above 184°C. at atmospheric pressure and below 150°C. at 2-mm. mercury pressure was extracted with 5% aqueous sodium hydroxide to remove acidic and phenolic substances. It was then treated with anhydrous magnesium chloride to remove oxygen compounds. The hydrocarbon fraction was fractionally distilled at a 20:1 reflux ratio. Because the distillation gave incomplete separation, the distillate was collected in 50-ml. cuts, which were diluted with methyl alcohol or acetone, depending on their solubility, and were stored at a temperature of −30°C. for 48 hours. Crystalline material that separated out was filtered off. The crystals proved to be the same long-chain hydrocarbons and alcohols found previously by the authors (*3*) in the extractives from Douglas-fir. The oils recovered after distilling off the solvent were redistilled in a distilling column having the efficiency of 100 theoretical plates (*13*). The distillation curve, the index of refraction, the methoxyl content by the method of Hoffman and Wolfrom (*7*), and the hydroxyl content by the method of Ogg, Porter, and Willits (*10*) are shown for the various fractions in Fig. 6.

Table I. Products from the Hydrogenation of Douglas-Fir Lignin Residue

Product	*Dry lignin residue, %*
Hydrocarbons distilled below decalin	4.3
Neutral oxygen compounds distilled below decalin	2.0
Hydrocarbons distilled above decalin	19.5
Neutral oxygen compounds separated above decalin	0.5
Total neutral products distilling below 150°C. at 2 mm. Hg	26.3
Acids and phenols	3.8
Water-soluble products	1.2
Tars distilling above 150°C. at 2 mm. Hg	7.3
Pitch	11.6
Unreacted residue	29.3
Water from reaction	4.8
Gases from reaction and losses (by difference)	15.7
	100.0

Carbon and hydrogen determinations by the method of Niederl and Niederl (*9*) were made on the fractions at the maximums and minimums of the refractive-index curve. These values are given in Table II. The empirical formula indicates the presence of hydro derivatives of condensed polynuclear aromatic compounds. Bromination, oxidation, or the formation of derivatives of hydroxy groups did not produce derivatives that were of any assistance for characterization of the products.

Since these analyses and the solubility of the fractions in cold concentrated sulphuric acid indicated that they were probably mixtures, the fractions were separated into crystalline and noncrystalline products by freezing them individually or in groups in a petroleum-ether solution at a temperature of −70°C. This treatment resulted in the isolation of about 20% of the neutral oils as crystalline products. These were identified as aliphatic compounds that had been incompletely removed by crystallizing at −30°C.

The oil fractions recovered from the solvent were

Table II. Analysis of Neutral Oils Distilling Above 184°C.

Fraction	Boiling range, °C.	Hydroxyl, %	Methoxyl, %	Hydroxyl O + methoxyl O, %	Combustion analysis: Carbon, %	Hydrogen, %	Oxygen,[a] %	Oxygen other than OH and OMe, %	Empirical formula
7	98.0–100.5[b]	4.65	..	..	77.84	11.44	10.22	..	$C_{9.7}H_{16.9}O$
11	107.0–109.5[b]	5.12	2.86	6.29	76.80	11.52	11.68	5.4	$C_{8.9}H_{15.7}O$
15	115.0–117.0[b]	5.02	1.66	5.59	81.20	11.19	7.61	2.0	$C_{14.2}H_{23.4}O$
19	124.0–127.0[b]	4.70	1.57	5.24	80.28	11.50	8.22	3.0	$C_{11.7}H_{21.9}O$
27	113.0–115.0[c]	3.90	0.95	4.15	83.15	11.71	5.14	1.0	$C_{21.6}H_{36.3}O$
30	121[c]	3.28	0.74	3.47	83.20	11.86	5.14	1.7	$C_{18.7}H_{31.7}O$
34	126.0–128.0[c]	2.64	0.72	2.85	83.70	11.40	5.22	2.4	$C_{21.7}H_{34.4}O$
40	136.0–137.5[c]	3.44	0.62	3.52	83.70	11.40	4.60	1.1	$C_{24.1}H_{39}O$

[a] By difference
[b] Under pressure of 10 mm. of mercury.
[c] Under pressure of 2 mm. of mercury.

dehydrogenated by heating in purified benzene in the presence of a platinum-activated carbon catalyst by the method of Adkins (*2*).

In a typical dehydrogenation, 2 grams of catalyst, 5 grams of neutral oil, and 30 ml. of benzene were heated in a 230-ml. bomb for 10 to 12 hours at 300°C. The

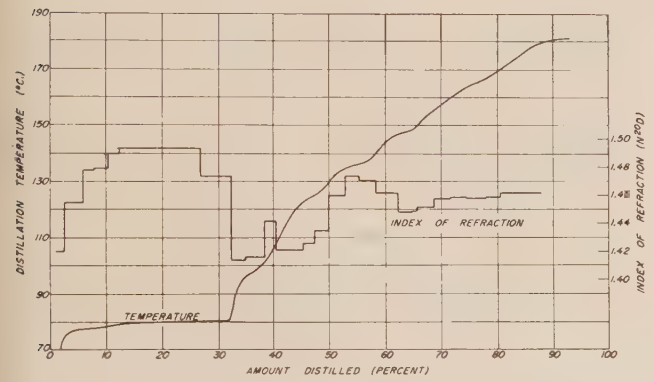

Fig. 4. First distillation of neutral oils distilling below decalin

product was separated from the catalyst, extracted with 5% aqueous sodium hydroxide to remove phenolic substances, stripped of benzene, and frozen in petroleum-ether solution at −70°C. (Fig. 8). Crystalline naphthalene, diphenyl, and dibenzyl were separated in this manner and identified. Table III shows the products isolated from the various fractions.

OXYGEN COMPOUNDS IN THE NEUTRAL OILS

Anhydrous magnesium chlorine reacts with alcohols and ketones to form insoluble compounds and has thus been used (*6, 11, 12*) to remove alcohols and ketones from hydrocarbon mixtures. The neutral oils boiling below 184°C. and those boiling above 184°C. were also separated with anhydrous magnesium chloride.

The products boiling below 184°C. as shown in Fig. 4, were combined into seven fractions representing adjacent boiling ranges. Each of these fractions was diluted with about equal parts of petroleum ether (boiling range 40 to 65°C.) and was shaken for 24 hours at room temperature with 10% of its weight of anhydrous magnesium chloride which passed through a 20-mesh screen. The solid was removed from the mixture by centrifuging and was washed with petroleum ether. The washings were combined and added to the unreacted oil and concentrated. The oil was treated repeatedly with anhydrous magnesium chloride until no more products were removed. Thirty per cent of the low-boiling neutral oil was removed as a complex. The oxygenated compounds were recovered by decomposing the complex with water, followed by steam distillation. The oil was removed from the condensate by extraction with ether, dried over anhydrous calcium sulphate, and fractionally distilled. The distillation curve is shown in Fig. 7. Cyclohexanone, cyclohexanol, and 4-methylcyclohexanol were identified in the fractions.

The oil boiling above 184°C. was treated with anhydrous magnesium chloride in a similar manner, but only 2.4% of the oil formed a complex. Subsequent work has shown that the reaction was incomplete and that all the oxygen-containing compounds were not removed

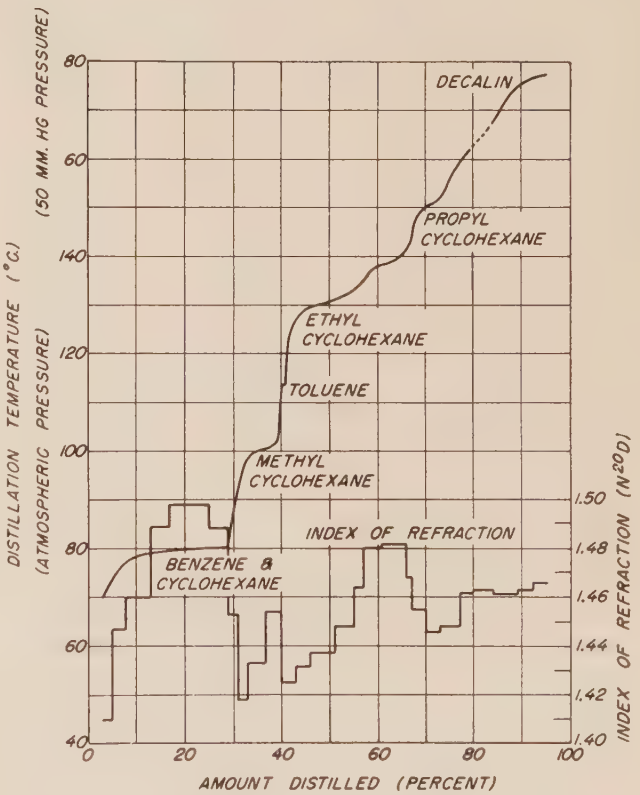

Fig. 5. Hydrocarbons distilling below decalin

from these higher-boiling, higher-molecular-weight compounds. The fractions were distilled under diminished pressure. No pure compounds were identified. The lowest boiling products from the fraction were insoluble in cold concentrated sulphuric acid; the highest-boiling products were 70% soluble.

Table III. Dehydrogenation Products of High-Boiling Hydrocarbons

Original fraction distilling at °C.	Index of refraction at 20°C.	Dehydrogenated product distilling at atmospheric pressure, °C.	Composition	Product from second freezing
114–115[a]	1.5250 (Original 1.4892)	250–260	Oil, including 3% phenols	Oil + naphthalene
115–119[a]	1.5230 (Original 1.4910)	...	Oil, no phenols	Oil + 7% dibenzyl
119–124[a]	1.5220 (Original 1.4870)	...	Oil, including 7% phenols	Oil + 6.5% dibenzyl
111–115[b]	1.525 (Original 1.4990)	...	Oil, including 6% phenols	Oil
115–119[b]	1.5360 (Original 1.5030)	217–248	Oil, including 6.7% phenols	Oil
119–121[b]	1.5373 (Original 1.4980)	...	Oil	Oil
125–128[b]	(1) 1.5160; (2) 1.5530; (Original 1.4992)	220–225 >225	Oil + trace phenols	Oil + unidentified crystals, m.p. 90–92; C, 88.89%; H, 9.45%
128–130[b]	.....	...	Oil + trace phenols	Oil + diphenyl
137–137.5[b]	1.50–1.52 (Original 1.508–1.511)	260–320	Oil	Oil

[a] Under pressure of 10 mm. of mercury.
[b] Under pressure of 2 mm. of mercury.

PHENOLS AND ACIDS

The phenols and acids were recovered from the water-insoluble oils, as shown in Fig. 2. The acid fraction consisted mainly of acetic acid. Fractional distillation of the phenols yielded two fractions that were identified as phenol and para-ethylphenol.

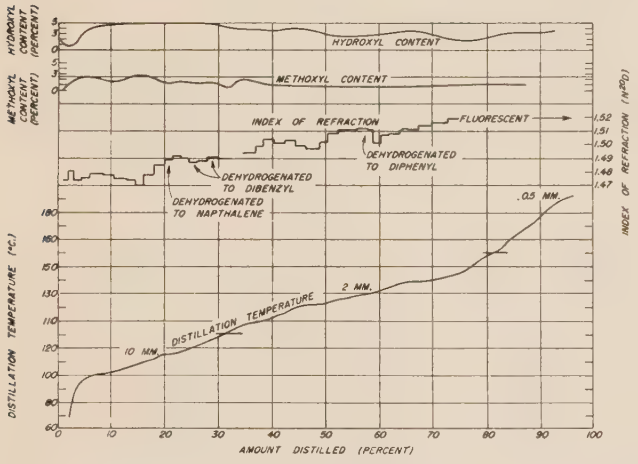

Fig. 6. Neutral compounds distilling above decalin

Crystalline derivatives were prepared from other fractions, but none were pure enough for identification. The phenols and acids distilling above 184°C. were set aside for later study.

CHARACTERIZATION OF DISTILLATION PRODUCTS

Hydrocarbon Fractions

Cyclohexane. The fraction (Fig. 5) boiling at temperatures between 79 and 81°C. was shown by the refractive index and specific gravity to be a mixture of benzene and cyclohexane.

Methylcyclohexane. The fraction (Fig. 5) boiling at temperatures between 97.5 and 100.5°C. was identified as methylcyclohexane. Its refractive index (n_D^{20}) was 1.4235; its density (D_4^{20}) was 0.7696; and its composition was 85.58% carbon and 14.39% hydrogen. Reduction over platinum on asbestos at 340 to 350°C. converted it to toluene, boiling point 109°C., refractive index (n_D^{20}) 1.492. Oxidation converted the toluene to benzoic acid, melting point 120°C.

Toluene. The fraction (Fig. 5) boiling at temperatures between 103 and 114°C., after being washed with cold concentrated sulphuric acid and water, had a refractive index (n_D^{20}) of 1.4906, a density (D_4^{20}) of 0.868, a boiling point of 109 to 110°C. and, on oxidation with potassium permanganate, yielded benzoic acid having a melting point of 121.5°C.

Ethylcyclohexane. The fraction (Fig. 5) boiling at temperatures between 130 and 131°C. had a refractive index (n_D^{20}) of 1.4370 and a density (D_4^{20}) of 0.7877. These values agree with those of ethylcyclohexane.

Propylcyclohexane. The fraction (Fig. 5) boiling at temperatures between 150 and 152°C. had a refractive index (n_D^{20}) of 1.4458 and a density (D_4^{20}) of 0.7902. These values correspond to those of *n*-propylcyclohexane.

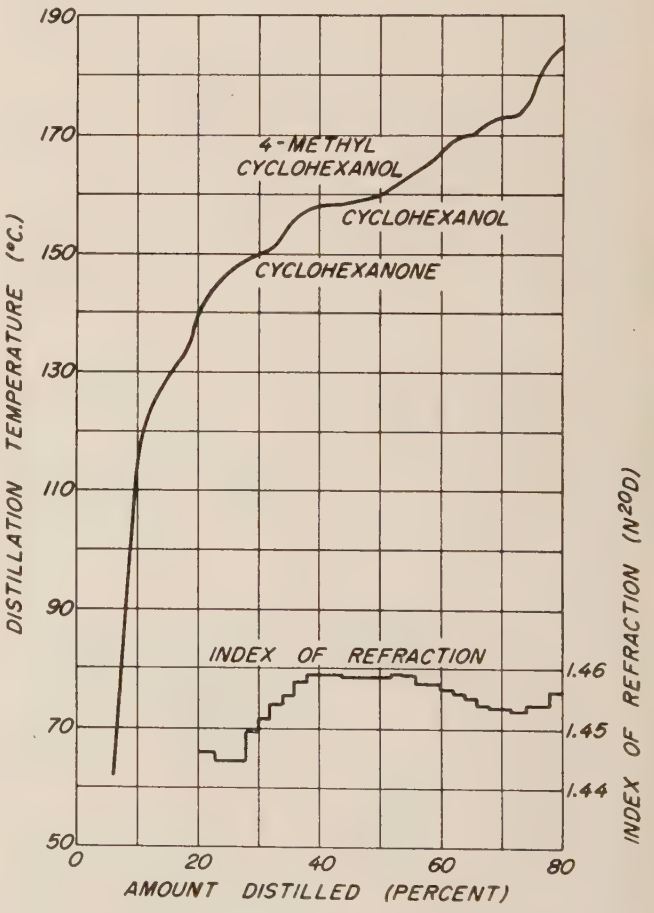

Fig. 7. Oxygen compounds distilling below decalin

Naphthalene. The fraction (Fig. 6) boiling at a temperature of 114 to 115°C. at a pressure of 10 mm. of mercury was dehydrogenated. The dehydrogenated product had a refractive index of 1.5250 at 20°C. A crys-

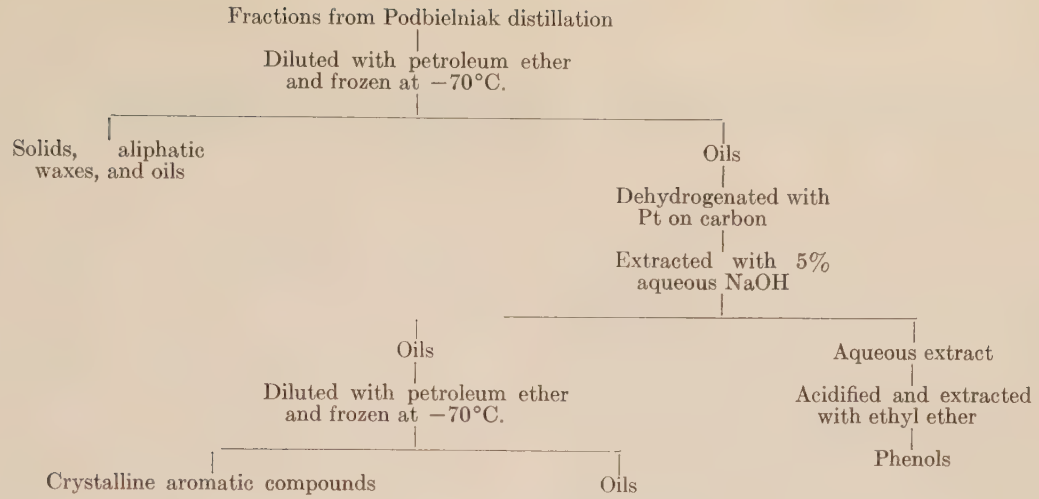

Fig. 8. Separation of high-boiling hydrocarbon fractions

talline product separated from the mixture on cooling. After recrystallization it had a melting point at 80°C. and the characteristic odor of naphthalene. A mixture of the product with pure naphthalene showed no depression of melting point. The product from which the naphthalene was produced by dehydrogenation boiled at temperatures 25 to 55°C. higher than naphthalene or any of its hydrogenated derivatives and, therefore, must have represented some larger fragment from the cleavage of lignin.

Dibenzyl. The fraction (Fig. 6) boiling at a temperature between 115 and 124°C. at a pressure of 10 mm. of mercury was dehydrogenated. On cooling, a crystalline product separated that had a melting point at 52.5°C. and a composition of 91.83% carbon and 7.97% hydrogen. A mixture of the product with pure dibenzyl had no depression in melting point. The 2,4,2′,4′-tetranitro derivative of the product (*14*) had a melting point at 170°C., which agreed with that of a similar derivative of pure dibenzyl.

Diphenyl. The fraction (Fig. 6) boiling at temperatures between 128 and 130°C. at a pressure of 2-mm. mercury was dehydrogenated and yielded a crystalline product by cooling. This was purified by a chromatographic means in a column of alumina and by recrystallization. The product had a melting point at 67°C. and a composition of 93.31% carbon and 6.75% hydrogen, which values agreed with those of pure diphenyl.

Oxygen Compounds in the Neutral Oils

Cyclohexanone. The fraction (Fig. 7) distilling at temperatures from 150 to 153°C. had an index of refraction (n_D^{20}) of 1.4505. It was converted to a 2,4-dinitrophenylhydrazone derivative that was found to be a mixture. The mixture was separated by chromatographic methods on alumina. The upper band was recovered and gave a product melting at 161.5°C. A mixture of this derivative with the derivative of pure cyclohexanone melted at 161.5°C. The derivative in the lower band melted at 114°C. and was not identified.

Cyclohexanol. A fraction (Fig. 7) distilling at temperatures from 158 to 160°C. had an index of refraction (n_D^{20}) of 1.4590, formed a 3,5-dinitrobenzoate having a melting point at 110°C., and had a composition of 53.11% carbon, 4.81% hydrogen, and 9.55% nitrogen. An alpha-naphthylurethane derivative melted at 128°C. These values correspond to those obtained with pure cyclohexanol.

4-Methylcyclohexanol. The fraction (Fig. 7) distilling at temperatures from 158 to 160°C. had an index of refraction (n_D^{20}) of 1.4534, formed a 3,5-dinitrobenzoate with a melting point of 138°C., and had a composition of 54.32% carbon, 5.10% hydrogen, and 9.13% nitrogen, and formed a phenyl urethane with a melting point at 125°C. These values correspond to those obtained with pure trans 4-methylcyclohexanol.

Phenols from Neutral Oils

Para-ethylphenol. A fraction of the phenols from neutral oils, distilling at temperatures between 134 and 147°C. at a pressure of 100 mm., formed a phenylurethane melting at a temperature of 112 to 116°C. This substance was separated into two fractions, one the phenylurethane derivative of para-ethylphenol melting at a temperature of 120.5°C. and the other melting at 130°C. The latter derivative was not identified.

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Application of Hydrogen Sulphide in Sulphidity Control

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Sulphur will react under proper conditions with caustic soda, soda ash, or lime to form hydrogen sulphide and sodium thiosulphate. Under similar conditions sulphur will react with lime to form hydrogen sulphide and calcium monosulphite. The hydrogen sulphide in each case is evolved as a gas and can be absorbed in kraft white liquor to adjust the sulphidity upward. The by-product thiosulphate may be added directly to the white liquor or it may be added to the black liquor going to the furnace. The by-product calcium monosulphite may be reacted with the soda ash in the green liquor to form sodium monosulphite which can be added to the white liquor.

THE introduction of hydrogen sulphide directly into the white liquors as a means of restoring the desired sulphidity probably has not been given serious consideration in the past because of economic or technical problems in its production, handling, or transportation. Several years ago a process for generating hydrogen sulphide was developed and reported in the literature (*1*, *2*). At that time, kraft mills were more concerned with reduction of sulphidity due to the high salt cake consumption then prevalent. Since then, advances have been made in reducing the inorganic chemical losses which favor the recovery of sodium over that of sulphur. In view of these developments, it is the purpose of this paper to call attention to an economical process for producing hydrogen sulphide at the point of use and to offer suggestions on its application in the kraft liquor cycle.

The process is based on the interaction of elemental sulphur with any one of several common alkalies in the presence of water and under conditions of temperature and pressure which permit the separation of gaseous hydrogen sulphide.

REACTIONS INVOLVED

It has long been known that caustic alkali and sulphur react in some way to form monosulphides, polysulphides, and thiosulphate. The mechanisms involved are not well understood.

The early work on this process involved refluxing sulphur with a caustic alkali under atmospheric pressure. It was observed that small quantities of hydrogen sulphide were evolved after prolonged reaction periods. At this point the process was commercially impractical due to the low yield of hydrogen sulphide and to the time required. By boiling the mixture at higher than atmospheric pressures and at elevated temperature, it was found that the reaction could be made feasible. The following three equations can be assumed to represent the chemical reactions involved in the process as it was eventually worked out:

$$3S + 2H_2O \rightarrow 2H_2S + SO_2 \quad (1)$$

$$SO_2 + 2\,NaOH \rightarrow Na_2SO_3 + H_2O \quad (2)$$

$$Na_2SO_3 + S \rightarrow Na_2S_2O_3 \quad (3)$$

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The over-all reaction may be expressed by this equation:

$$4S + 2NaOH + H_2O \rightarrow 2H_2S + Na_2S_2O_3 \quad (4)$$

Soda ash, sodium sulphide, or lime may also be used effectively as the alkali. The over-all equations with these alkalies are as follows:

$$4S + Na_2CO_3 + 2H_2O \rightarrow 2H_2S + Na_2S_2O_3 + CO_2 \quad (5)$$

$$4S + Na_2S + 3H_2O \rightarrow 3H_2S + Na_2S_2O_3 \quad (6)$$

$$3S + Ca(OH)_2 + H_2O \rightarrow 2H_2S + CaSO_3 \quad (7)$$

The divergence of the reaction involving lime from the general pattern is worthy of note. The presence of the monosulphite found in the reactor at the conclusion of a reaction between lime and sulphur appears to support the proposed reaction mechanism given above. However, this end result may be due to decomposition of calcium thiosulphate to the monosulphite and elemental sulphur under the conditions employed in the hydrogen sulphide generation reaction.

THE REACTOR

The hydrogen sulphide generation can be carried out conveniently in a steel vessel similar to the one illustrated in Fig. 1 if direct steaming is employed. If indirect steaming is chosen, additional equipment in the form of heating tubes and a reflux condenser must be provided.

The choice between direct and indirect methods of heating depends largely on the ability of the white-liquor system to absorb the moisture vapor present in the hydrogen sulphide gas stream. The moisture amounts to 5 to 10 pounds of water per pound of hydrogen sulphide generated in uninsulated vessels located out of doors. It is not feasible to condense out the moisture in a direct steaming operation because such condensate must be sewered and the dissolved hydrogen sulphide would represent a hazard. Return of this condensate to the reactor would interfere with the reaction by unduly diluting the reactants. It is necessary to condense out the moisture from the gas stream where indirect steaming is used in order to avoid desiccation of the reactants. Pulp mills have favored the direct operation principally because of the simpler equipment involved. Work done so far has not shown any noteworthy difference between the efficiencies obtained by the two methods of heating under the conditions employed.

The relationship between the generator volume capacity and weight of hydrogen sulphide produced is a variable, dependent chiefly on the operating conditions imposed. Sufficient space must be provided in the reactor to accommodate the reactants plus the space required for the foaming caused by boiling. Where insufficient space is provided for the foaming, elemental sulphur or sodium polysulphide may be carried over mechanically into the gas delivery line. Data on two

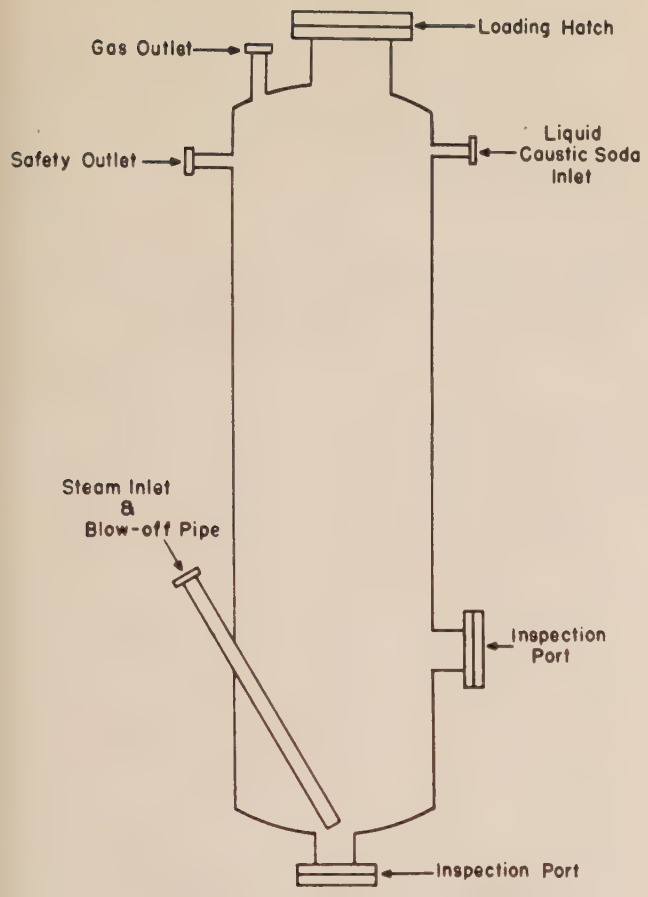

Fig. 1. Reactor for hydrogen sulphide generation

units are tabulated below to illustrate the suggested relationship:

Both of the above units were designed for outside operation without lagging. Where such protection against heat loss is provided, the turbulence within the reactor will be reduced and the capacity may be increased accordingly.

The generators constructed to date have been built of steel. Although some corrosion has been noted, the service given by steel has been considered satisfactory and there has been little incentive to explore the possibilities of other metals or alloys. It may be noted at this point that less corrosion has been observed in indirectly heated units than has been true of the directly heated generators.

Steel auxiliary fittings have been found satisfactory with a few exceptions. It has been found necessary to use stainless-steel trim in the pressure-regulating valve located on the gas outlet. Rather severe corrosion in the gas delivery line has made it necessary to replace the steel pipe with a tube made from 316 stainless steel.

The safety outlet is closed by means of a frangible platinum disk. Due probably to the heat, these units

Table I

	Unit No. 1	*Unit No. 2*
Height, ft.	18	8.8
Outside diameter, in.	42	30
Chemicals charged, lb.		
NaOH	750	250
S	1200	400
Yield, lb.		
H_2S	625	208
$Na_2S_2O_3$	1470	485

Table II

Average reaction temperature, °F.	*Reaction time, min.*	*Per cent of original sulphur unreacted*
277	240	32.1
287	240	12.9
310	180	7.0
316	200	None
326	160	None

failed rapidly when placed close to the reactor body. This difficulty was overcome by inserting a length of pipe between the disk and the generator body.

REACTION VARIABLES

The most important reaction variable is the temperature as might be expected. A number of pilot plant runs were made to check this and other points. Data obtained from these runs illustrate the importance of temperature:

The unreacted sulphur noted in the above tabulation was undoubtedly present as a polysulphide but it may be considered unreacted for our present purpose.

Data which will permit accurate evaluation of the effect of the original concentration of chemicals are not available. With directly-heated reactors, it has been found to be advantageous to employ anhydrous chemicals at the start of the reaction for obvious reasons. The only exception has been in the case of caustic soda where 50% solutions have been found to be more economical. Water is necessary to the reaction. Therefore, it is necessary to add water to the reaction mixture when indirect heating is employed. The quantity of water to be added depends upon the reaction temperature selected. No work has been done with solutions approximating the composition and concentration of white liquor. Because of their degree of dilution, they would be expected to raise the steam consumption, extend the reaction time, and reduce the generator capacity. A unit such as that illustrated would not be an efficient evaporator.

RECOMMENDED OPERATION

Caustic soda, soda ash, sodium sulphide, and lime will react with sulphur as indicated in equations (4), (5), (6), and (7). The choice of the most suitable alkali often is dependent on purely local considerations such as availability, comparative delivered costs, and value assigned to the byproducts.

So far, caustic soda alone has been used as the alkali for pulp-mill operation. The products obtained with it (equation 4) are all soluble and useful. It is convenient to handle and quite effective. In addition, sulphur can be dissolved in caustic soda solutions and pumped into the reactor, thus eliminating the necessity for removing the loading hatch cover between operations. This represents an important savings in labor.

Soda ash is equal in effectiveness with caustic soda and the reaction products are soluble (equation 5). It can readily be obtained in anhydrous form. The principal objection to its use is that the carbon dioxide evolved with the hydrogen sulphide would act to reduce the causticity of the cooking liquor.

Sodium sulphide is not a practical reagent for this operation. It possesses no advantage over caustic soda, and it is normally more expensive. Its use is mentioned here principally to illustrate that the sodium sulphide

content of white liquors would offer no handicap to the use of these liquors as the alkali. However, as mentioned above, the low chemical concentration of white liquor would represent an obstacle.

Lime has not been employed in any full-scale operation. The use of lime is restricted to directly-heated reactors since the insoluble calcium sulphite formed would scale out on the heating tubes and interfere with the heat transfer. In directly-heated units, the turbulence maintained by the incoming steam avoids scale formation by keeping the calcium sulphite in suspension. Where lime is used, provisions must be made to handle a liquid-solid residue instead of the liquids associated with the use of caustic soda or soda ash. Its use has the advantage that roughly two thirds of the sulphur is converted directly to hydrogen sulphide compared to one half when soda products are used.

Chemicals should be added in stoichiometric proportions as indicated in equations (4), (5), (6), and (7). Any excess of sulphur present remains as unreacted material at the close of the reaction. It is suggested that unless extremely accurate methods are available for weighing the chemicals, small excesses of alkali be provided. Relatively crude measuring methods such as volumetrically measuring the sulphur and alkali can be used if the small excess of alkali is provided.

Steam is admitted to the generator at as high a rate as possible until the unit and its contents approach the desired reaction temperature. Hydrogen sulphide evolution begins rapidly as the reaction temperature is reached and diminishes as the reaction progresses. The rate of flow of the steam is decreased when the desired temperature is reached. Since all existing operations are carried out in uninsulated vessels located out of doors, no data are available on optimum values for steaming rate. It has been necessary to determine the optimum values by cut-and-try methods.

When the evolution of hydrogen sulphide ceases, the reaction is complete. At this point, the steam inlet and gas outlet valves are closed. The reactor contents are forced out of the vessel by means of the residual pressure. The steam inlet line shown in Fig. 1 can conveniently be used for this purpose if it is properly connected through a Y fitting to the steam source and the residue receiver.

Hydrogen sulphide is extremely soluble in dilute caustic soda solutions. Because of this, no difficulties have been experienced in absorbing the gas in the white liquor, and no absorption columns have been found to be necessary. Immersion of the gas delivery line into the white liquor well below the surface has been found to be adequate. However, it is suggested that the gas be introduced into the white liquor through a simple diffuser to help break up any large bubbles. Such a diffuser could be fabricated by capping a piece of 2-inch pipe and perforating the pipe walls.

UTILIZATION OF THE BY-PRODUCTS

Sodium Thiosulphate

Approximately half of the sulphur going into the reaction emerges as sodium thiosulphate when caustic soda or soda ash is used and remains in the reactor at the conclusion of the operation. In those mills where it is considered beneficial to the pulping reaction, it can be added directly to the white liquor. Where it is held to be detrimental, it can be added to the black liquor going to the recovery furnace.

Although it may be commercially impractical, it is of interest to note that the sodium thiosulphate can be converted to sodium sulphide and sodium sulphite according to the reaction:

$$2Na_2S_2O_3 + 6NaOH \rightarrow 2Na_2S + 4Na_2SO_3 + 3H_2O \quad (8)$$

The thiosulphate remaining in the generator after the evolution of hydrogen sulphide can be treated with additional caustic soda to effect this reaction. The important factors influencing this reaction are the temperature and the amount of water present. Data obtained from a laboratory study of the reaction indicate that optimum conversion can be obtained at temperatures in the range of 400°F., and when the water content is maintained below 25%. Approximately 95% conversion can be obtained under these conditions.

Calcium Sulphite

Because of the relative solubilities of calcium sulphite and calcium carbonate, soda ash will react with calcium sulphite to form calcium carbonate and sodium sulphite:

$$CaSO_3 + Na_2CO_3 \rightarrow Na_2SO_3 + CaCO_3 \quad (9)$$

Soda ash of the concentration found in green liquor will conveniently effect the conversion. Although no attempts have been made, it would appear that this reaction might be carried out in the causticizers or possibly in the dissolver if the calcium carbonate sludge does not overtax the green-liquor clarifier. The work done on lime-sulphur reactions has been too limited to permit accurate evaluation of their potentialities. Through use of this operation, it may be possible to obtain unlimited control of the sulphidity since the sulphur is furnished to the system in a useful form without adding to the soda inventory.

It is also possible to utilize the calcium sulphite in the same manner as gypsum has been used in the past.

Precautions

Although no serious difficulties have occurred, it should be kept in mind that hydrogen sulphide is poisonous. Positive steps should be taken to eliminate any hazards such as leaks which might occur. All existing generation equipment is located out of doors where there is less chance of building up dangerous concentrations of the gas.

When indirect heating is employed, there is often residual hydrogen sulphide in the generator at the conclusion of a reaction. This represents a hazard when the cover is removed. This can be eliminated by providing and using an air line for purging of the gas space before the cover is lifted. The use of direct steam appears to effectively remove all traces of the hydrogen-sulphide gas and it has not been found necessary to provide for air purging where this method of heating is employed.

SUMMARY

1. A process is available for generating hydrogen sulphide at the point of use from sulphur and any one of several common alkalies.

2. The major by-products are thiosulphates or monosulphite, depending on the alkali used.

3. The by-products can be readily utilized in the pulping operation.

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Presence of Galactose Units in Unbleached Kraft Pulps

LOUIS E. WISE, RUTH C. RITTENHOUSE, and CONSUELO GARCIA

Two sulphate pulps prepared from western hemlock and Douglas-fir (the analyses of which were reported previously by Lewis, Wise, and Browning (*1*)) were hydrolyzed and examined for galactose by the methods of paper partition chromatography.

Approximately 25 grams of air-dried shredded pulp were refluxed 8 hours with 1 liter of 0.1 *N* sulphuric acid. The hot filtered solution was neutralized carefully with barium carbonate, the filtrate acidified very slightly with acetic acid, evaporated on the steam bath to a thin sirup, and treated with a large excess of alcohol to precipitate the greater portion of the barium salts. The slight amount of residual barium ion was then removed by cautious titration with dilute sulphuric acid. Following filtration, the excess of acid was neutralized with minimal amounts of sodium bicarbonate. The clear filtered solution from either pulp showed a marked reducing value toward Fehling solution. Preliminary paper partition chromatograms (*2*) indicated that the following simple sugars were present in the aqueous solution: galactose, arabinose, and xylose. Apparently glucose and mannose were absent. The "sugar" spot development involved the use of an aniline acid phthalate solution in butanol, as proposed by Partridge (*3*). This technique permits differentiation of the pentose sugars (which show pink or reddish spots) from the hexoses which are spotted brown.

Inasmuch, however, as the clean-cut differentiation of glucose and galactose presents difficulties, the solutions were fermented by means of *Saccharomyces bayanus* (N.R.R.L. No. 966), a yeast which destroys D-glucose and D-mannose quantitatively without seriously affecting galactose or the common pentoses (*4*). Instead of the usual fermentation period (i.e., shaking for 24 hours), the mixtures were shaken only about 7 hours and were then allowed to stand overnight at 30°C. without further agitation. Subsequently the fermentation liquors were filtered, the clear filtrates evaporated to a small volume, and cleared as far as possible from protein "debris" by precipitation with alcohol. The evaporation and precipitation were carried out several times and the final yellow sirups (free from alcohol) were rechromatographed. The two solutions (from Douglas-fir and western hemlock) gave clear chromatograms for galactose, xylose, and arabinose, thus confirming the results of the chromatograms made prior to fermentation.

The presence of galactose in the sugar mixture from Douglas-fir pulp was also confirmed by oxidation to mucic acid by means of nitric acid. The mucic acid melted at 219 to 220°C. (with decomposition) and showed no depression when mixed with an authentic sample. The amounts of galactose present, however, were very small, and only a few milligrams of mucic acid were actually isolated. The presence of arabinose confirms the previous findings of Wise and Rittenhouse (*5*) who showed that such units were present in jack pine kraft pulp. Although galactose has been found repeatedly in hydrolyzates from coniferous woods (*6–10*), this appears to be the first time that the presence of galactose units has been shown unequivocally in any pulp. The results indicate that, in Douglas-fir and western hemlock, galactose units are present in traces in the hemicelluloses of the cell wall. It is also interesting to note that, by heating with 0.1 *N* acid, the cellulosic glucose units appear to remain entirely unaffected. This would indicate that differential pulp hydrolyses may well be possible. Certain sugar spots in the paper partition chromatogram were in the region of the di- and/or trisaccharides. In such areas pink "pentose" sugar spots were especially apparent. This would indicate either that intermediate oligosaccharides are present in the pulp hydrolyzates or, what is far less probable, that even 0.1 *N* acid can give rise to sugar reversion products. The results thus far with unbleached kraft pulps indicate that, although the principal sugar units (other than glucose) in such pulps are definitely mannose and xylose, very small amounts of arabinose and galactose units are also present. The latter can be concentrated and identified by partial hydrolysis with acids sufficiently dilute to permit the more common polysaccharides of the cell wall to remain largely unchanged.

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Factors Influencing the Service Life of Brick Linings in Sulphite Digesters

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To maintain a balance between tensile and compressive stresses in a brick digester lining so that a tight seal between lining and shell is always maintained, it is necessary to consider the "residual" compression which normally builds up in a lining. The "residual" stress develops relatively slowly to a point of approximate constancy and depends upon the water swelling and elasticity of the materials. The combined stress caused by water swelling and thermal expansion should at all times be great enough to exceed all influences tending to cause tension but should not be so great as to exceed the strength of the lining or lining materials. Actual temperature measurements taken at numerous points in a digester lining and shell show the variations in the temperature gradients throughout the cooking cycle and under varying conditions. The results of this work emphasize the need for consideration of such factors as external temperatures, cold air drafts, installation temperatures, sudden heating or cooling of the face of the lining, and other influences which frequently and alone might not be considered important. Whereas the lining materials are chosen and the lining designed so that sufficient safety is incorporated to compensate for some irregularities, nevertheless an accumulation of irregularities all acting to increase the effects in one direction may reduce the service life of a lining or cause excessive maintenance. On the other hand, general recognition of these less obvious factors should aid in extending the average life of digester linings even beyond the present-day average.

Among the more obvious factors influencing the service life of brick linings in sulphite digesters may be listed: (1) the chemical resistance, porosity, spall resistance, elasticity and strength of the brick and other components of the lining. (2) The thicknesses, thermal conductivities, and thermal expansion characteristics of the lining components and of the lining as a whole. (3) The acid strength and chemical composition of the cooking liquor. (4) The relative severity and speed of the cooking operation.

These are factors about which definite information can be obtained. Adjustments can generally be made to satisfy the conditions involving these factors. Thus, when the acid strength is high, brick of greater chemical resistance and lower porosity may be used with some corresponding loss of mechanical spall resistance and elasticity. Also, lining thicknesses may be varied, taking into consideration the thermal conductivity and thermal expansion characteristics of the lining materials, to provide a balance between lining and shell so that compression in the lining and tension of the shell do not become excessive.

Several other factors affecting the life of digester linings are not so readily understood and frequently defy accurate determination. It is known that a lining should be in compression at all times if a tight seal between steel shell and brick lining is to exist. A certain minimum compressive stress is therefore necessary to compensate for or to overcome those form-changing factors which tend to cause a separation of the lining from the shell or a separation of the components of the lining.

Form-changing factors which contribute to the danger of cracking of the brick lining or of separation of the lining from the shell include: (1) the rapid cooling of the brick lining, especially its face, during blowing and during washing of the digester contents. (2) The operating pressure which tends to expand both lining and shell. (3) The differential expansion between the digester shell and the brickwork during the steaming period.

These factors must be given full consideration in the design and operation of the lined vessel, and provisions must be made so that compression of the lining is maintained even when these factors are operative.

RESIDUAL STRESSES

It has now become fairly well understood that compression accumulates in a lining reacting as a residual tensile stress in the shell. This "residual stress" is in addition to those stresses caused by differences in temperature and thermal expansion between shell and lining. In fact, it must exist in order to safely overcome those form-changing factors which tend to cause cracking of a lining or a separation of a shell from the lining. On the other hand, the magnitude of this residual stress must be understood so that the sum total of compressive stresses does not exceed the strength of the lining materials.

In a report of an investigation on the digester explosion in the Laurentide Company mill at Grand'Mère, Que., Keay pointed out (*1*, *2*) that it was not possible to account for the total compressive stress by considering thermal expansion alone. It was Keay who first reported (*3*) that subsequent to the lining of a digester compression accumulates in the lining reacting as a residual tensile stress in the shell. It was then suggested that the causes of the action might exist in the chemical and physical readjustment which takes place in the lining after it has been built in place.

After the investigation (*4*) of the digester explosion in Lancey, France, in 1927, Jarlier (*5*) explained the probability of the swelling of a brick lining. It was suggested that swelling of a brick lining might take place, upon soaking in the cooking liquors, in the same manner as for many other siliceous materials when immersed for prolonged periods in water or aqueous solutions. Tests made on unrestrained specimens show that the expansion tendency of brick may be

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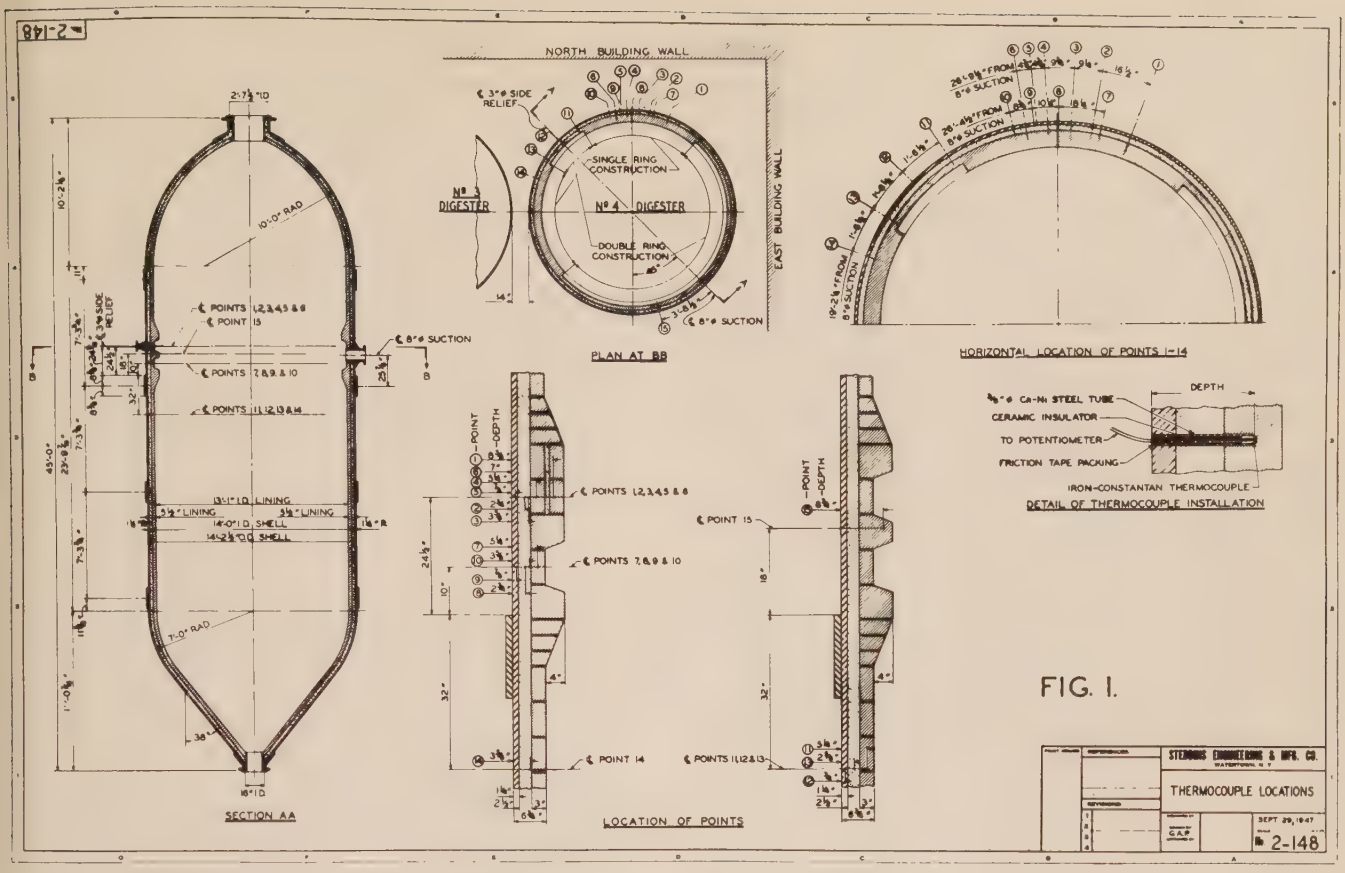

FIG. 1.

Fig. 1. Thermocouple locations

greater than the thermal expansion resulting from a 100°F. increase in temperature and that the expansion caused by wetting of ceramic materials in general varies much more than the thermal expansion (*6*).

Haas (*7*, *8*) has reported a rather thorough investigation made in Europe during the years 1933 to 1940 on the existence and magnitude of these residual stresses. The swelling tendency of the lining materials was definitely recognized. Haas shows that the magnitude of these residual stresses depends upon the extent of moisture swelling of the lining materials, on the thickness of the lining, and on the elasticity or compressibility of the lining components. It was found that the residual stress in the steel shell may reach as much as 11,000 p.s.i. presumably with corresponding compression in the brickwork. The maximum residual stress is generally reached after more than 1 year of service; within 2 to 3 weeks a quarter of the maximum may be reached, and after 1 to 2 months half of the maximum may be reached. After approximately a year the residual stress approaches constancy.

Of the two factors contributing to the compression in the lining, the one is practically constant whereas the second is variable. Added compression due to temperature differences between shell and lining varies widely during each cooking cycle, from cooking cycle to cooking cycle and possibly from season to season. However, it is certain that failure or short life of a lining can usually be traced to other stresses than the total of compressive stresses, provided that the lining is properly designed, that proper choice of lining materials is made, and that certain precautions in operation are taken.

It is then accepted that a certain residual stress is necessary for a digester lining so that a tight seal between lining and shell can be maintained. Also, this residual stress should not be so great that additional stresses may bring the total stress so high as to cause severe spalling or a breakdown of the lining. Perhaps the most critical time is during the early life of a digester lining. At this time the residual stresses have not developed greatly and, therefore, may be overcome by reverse acting forces if care is not taken, and indeed, it is during such periods that leaks are most frequently encountered. Extreme conditions and careless operation can result in severe shell corrosion and cracking of the lining during the early life. It is also very important to guard against the excessive addition of stresses throughout the service life of the digester, whether these added stresses may work in the same direction or in the reverse direction to the residual stresses.

The coefficient of expansion of the steel is usually greater than that of the lining materials. The temperature of the steel, however, is normally sufficiently lower than that of the lining and the lining designed so that the thermal expansion tendency of the lining is usually slightly greater than the thermal expansion tendency of the shell. If, however, this temperature balance is greatly disturbed, separation and cracking of the lining or spalling of the lining may occur. A higher than normal relative temperature increase in the steel above the lining installation temperature will contribute to separation and cracking especially during the early life of the lining. On the other hand, a lower than normal relative temperature increase in the steel above the installation temperature will tend to exert a stress on

the lining which might be beyond the compressive strength of the materials, especially if the residual stress has reached a maximum.

Each report cited above was presented following a digester explosion or with the possibility of shell failure as the primary consideration. The stresses developed in the shell were therefore emphasized. No actual stress measurements were made on the lining, and with a single exception no temperature measurements were made on the lining. Haas reports (*8*) a temperature measurement at one depth in the lining, but there have been no available data on actual temperature gradients and temperature fluctuations in the lining.

Realizing the importance of temperature variations, a study was made of the thermal conditions existing in a digester lining and shell over a 2-year period. In this study the stability of the lining was the primary consideration. Since the heat flow through a lining varies during the cooking cycle and never reaches a steady state, the compression in a lining varies throughout the cooking cycle. Temperature measurements taken at several depths in the lining and in the shell therefore serve to check theoretically estimated temperature gradients. Assuming the residual stress to be relatively constant, the variation in the total compressive stress and the periods and conditions of highest and lowest compression become known. This complements the work of Haas and the other investigators and provides basic information for the analysis of conditions at all times during the cooking cycle.

Data were recorded at 6-month intervals during 1-week periods beginning with the start-up of the digester following the installation of a lining in a new shell. Special attention was given to variations and irregularities in environmental conditions. The lining consisted of $2^1/_2$ inches of grout and 3 inches of brick laid in

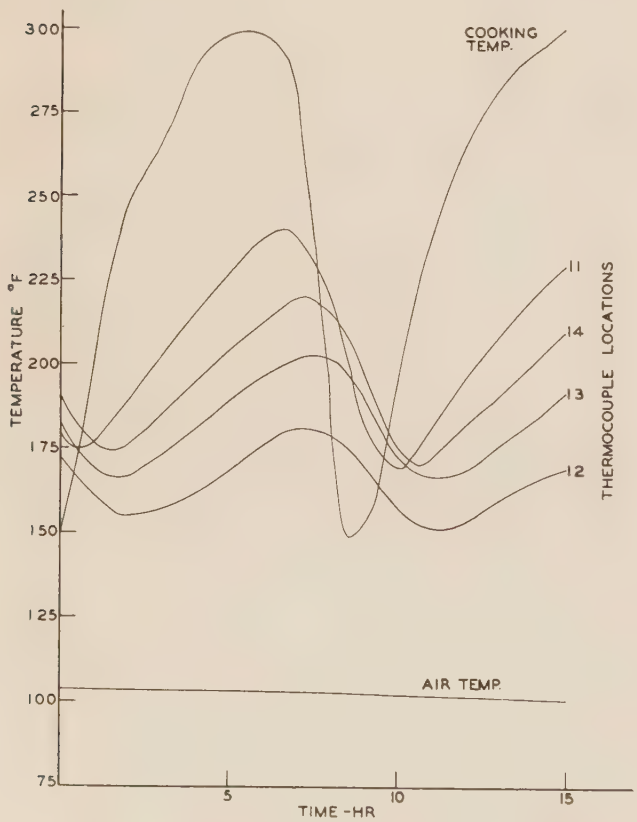

Fig. 2. Temperature vs. time in body section

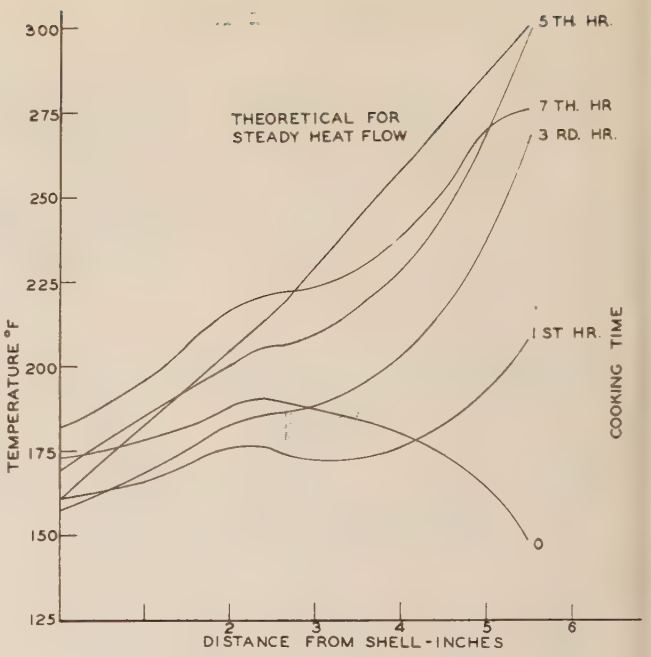

Fig. 3. Temperature gradients in body section

litharge-glycerine cement. Temperatures were taken by means of thermocouples placed in wells at various depths in the lining and shell and in various sections of the lining and shell. Fifteen thermocouple locations were used in all (Fig. 1).

The first set of six thermocouples was placed in the bricked-in portion of the upper collector ring channel where the lining is $9^1/_2$ inches thick. The second set of four thermocouples was placed in the lining behind the lower collector ring channel where the lining is $5^1/_2$ inches thick, and the third set of four thermocouples was placed in the body portion proper of the lining, 5 feet below the collector ring brickwork and where the lining is $5^1/_2$ inches thick. A single thermocouple was inserted into the center of the large brick in the collector ring section. This brick is surrounded by liquor on three sides.

Typical temperature curves (Fig. 2) representing conditions during normal operation and when external surrounding conditions were consistent, show that the shell temperature variation usually amounts to about 25°F. during the $8^1/_2$-hour cooking cycle. There is a period of about $1^1/_2$ hours during each cycle when the shell temperature may be higher than the brick face temperature, and the shell temperature reaches a maximum shortly after the blow when the temperature of the lining face is at its lowest. It is during this period that the difference in temperature between shell and lining as a whole is least, so that the expansion due to heat alone tends to be greater for the steel than for the lining. Therefore, there would be a tendency for shell and lining to separate if other factors do not compensate for or overcome this condition. Cold-water washing would exaggerate the condition, and in the early life of a lining before the residual stresses have developed there is a definite danger of separation.

Referring to the same curves, the difference in temperature between lining and shell is seen to be greatest shortly after the shell reaches its minimum temperature, or at about the fifth hour of the cook for the $8^1/_2$-hour cycle. Before the fifth hour the back

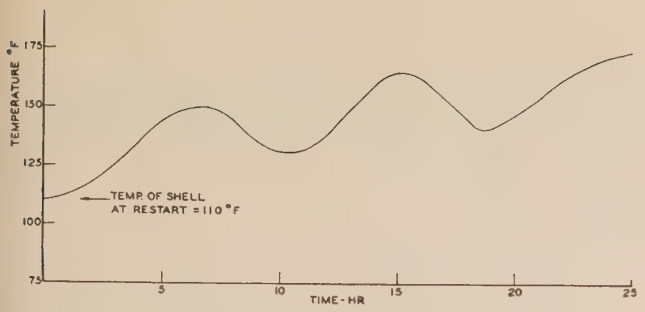

Fig. 4. Shell temperature following shutdown

and interior of the lining have been losing heat after the previous cook, and after the fifth or sixth hour the temperature of the lining as a whole rises faster than the temperature on the face of the lining, the latter having approached a maximum. The maximum or steepest temperature gradient in the lining is then at about the fifth hour. During this period compression on the brick is greatest, and care must therefore be taken that the lining is designed so as to resist the combination of residual and thermal stresses which may develop. Choice of materials and of proper thicknesses of materials is therefore of increased importance if some measure of control of the residual stress is to be maintained. Care in operation is also important during this period, since any outside influences which lower the shell temperatures, such as cold air drafts, will add to the compression of the lining.

For an $8^1/_2$-hour cooking cycle the heat flow through the lining never reaches a steady state but the temperature fluctuations in a lining are severe only in the face brick. Beyond the face $1^1/_2$ or 2 inches the temperature gradient is comparatively low, and the first major change in the temperature gradient occurs at a point corresponding to this distance from the face. This is shown by plotting temperature vs. distance from the shell (Fig. 3) and is significant because the choice of proper face brick thickness can be made only with due consideration of the cooking time and temperature.

CHOICE OF MATERIALS, THICKNESSES, AND INSTALLATION CONDITIONS

In the normal design of a digester lining, the materials and thicknesses of materials are so chosen that the expansion of the steel shell will be something less than that of the lining. During part of the cooking cycle it may be that the thermal expansion tendency of the shell will be greater than that of the lining, therefore the brick must have sufficient water swelling and elasticity to counteract this, but must not have so great a water swelling tendency as to increase the compression beyond the strength of the brick when the thermal expansion tendency of the brick again becomes greater than that of the shell. In spite of proper design and proper choice of materials, however, unusual conditions can frequently upset this balance.

If, for example, the lining installation is made during very hot weather, or when the temperature in the digester room is very high, the shell temperature increase during operation may not exceed 40°F. With only a 40°F. increase in shell temperature unnecessarily high compressive stresses on the brick may result. In fact, a period of time equivalent to about four cooking cycles may be required even to reach this increase. Figure 4 shows shell temperatures during the first four cooks following a week-end shutdown when the internal temperature was allowed to fall to 120°F. In the case of a low relative increase in shell temperature due to high installation temperatures, failure or spalling of the brick may not occur immediately but may be delayed for several months. When the residual stresses shall have had time to develop and are added to the compressive stresses due to thermal expansion, a lining may then be suddenly affected although initially it might have appeared to be quite stable. Such a condition may be exaggerated following a shutdown period.

Lining installations made under extremely cold conditions may also be subject to failure. The temperature increase of the shell and the corresponding thermal expansion would be relatively great. In the early life of a lining, before the residual stresses would have developed, this would tend to cause separation and leaking of the lining, and possibly cracking of the lining, especially at a time shortly after the digester is blown or during the early part of the steaming period.

The maximum temperature recorded on the shell during the 2-year experimental period was 196°F. in the summer when surrounding air temperatures were between 115 and 130°F. and no drafts were present. The lowest shell temperature under normal operating conditions was 141°F. when the surrounding air temperature varied between 90 and 105°F. Lower temperatures were obtained when an artificial air current was imposed on the shell. A seasonal difference in air temperature of 25°F. is accompanied by approximately 15°F. difference in average shell temperature.

The effects of drafts or air currents may be more pronounced than the effects of a change in air temperature. Figure 5 shows the effect of a 10 feet per second (7 m.p.h.) draft on the shell temperature. A temperature reduction of over 25°F. was obtained by means of such an air current without any reduction in the temperature of the air circulated. An air current of 10 feet per second would not be difficult to find where proper precautions are not taken. Open windows might very frequently allow more extreme conditions than this. The effect of an air current is seen to be all the more severe when it is realized that corresponding temperature reductions are not found in the lining; that is, the temperature at any specified depth in the lining is higher than is the case when the shell temperature is at an equal temperature because of lower air temperatures and in the absence of drafts.

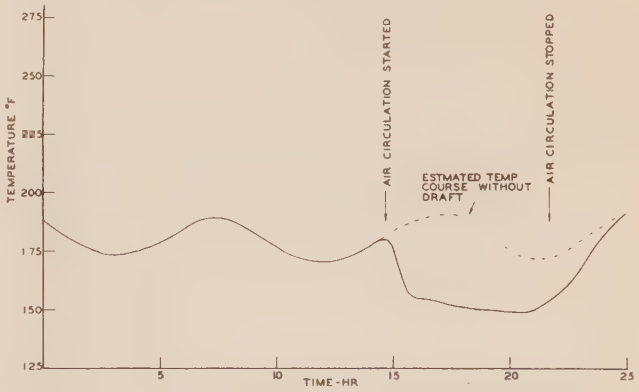

Fig. 5. Effect of air current on shell temperature

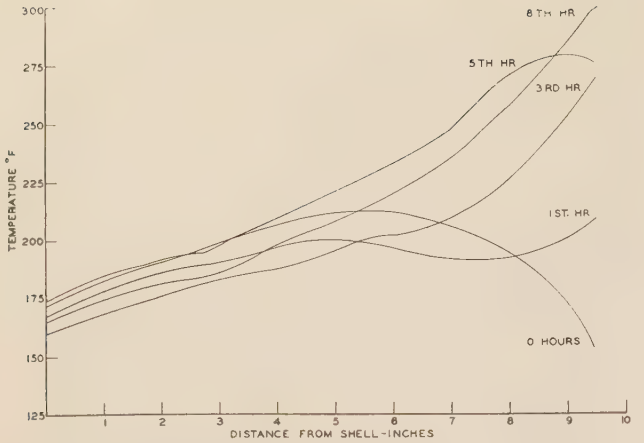

Fig. 6. Temperature gradients in collector ring section

Referring now to the collector-ring brickwork, the temperature drop across $9^1/_2$ inches of brickwork was found to be about equal on the average to the temperature drop across $5^1/_2$ inches in the body proper but with a 5° lesser fluctuation in the shell temperature at the collector-ring area. The temperature gradient (Fig. 6) therefore is less steep in the solid bricked-in portion of the upper collector-ring channel. This can be attributed to the effects of the adjacent body lining, to more massive brickwork which tends to equalize the heat flow, and to more rapid circulation of liquor in this section resulting in better transfer of heat from liquor to the brick surface. This less steep gradient does not necessarily mean that thermal stresses should be less in the collector-ring section. Actually the contour of the lining face is such that thermal stresses are exaggerated on the face brick. The area of exposed surface per square foot of shell is much greater and isotherms become very complex lines in the collector-ring brickwork as a result of the irregular shape of the surface.

As an example, it may be assumed that a lining installation is made at 75°F. and that the thermal expansion coefficients of the brick and steel are 0.0000032 and 0.0000061 per °F., respectively. Then at the height of a cook when the average temperature for the face 2 inches of brick may be 265° F. and for the shell may be 175°F., the thermal expansion tendency for the face 2 inches of brick is 0.00061 inches per inch and for the shell is also 0.00061 inches per inch. So considering the face 2 inches as a unit, this is in balance with the shell, and the only stress is the resultant of the predeveloped residual stress and the pressure in the digester. If, however, we consider the face 1 inch as a unit, this face 1 inch would tend to be in slight compression as a result of existing thermal conditions alone.

Linings are designed to be strong enough to resist the combined stress caused by the residual stress, pressure in the digester, and normal or controlled thermal conditions. However, any other influences such as those already discussed will contribute to excessive compression and premature spalling if the effect is additive to the residual stress and to separation or cracking of the lining if the effect is in the reverse direction to the residual stress.

SUMMARY

Summarizing these influences, we may list the following as requiring some notice:

1. Installation temperatures.
2. Seasonal air temperature differences.
3. Differences in air temperatures between day and night.
4. The temperature lag following a "shutdown."
5. Excessive conditions which might exist immediately after a blow and at about the middle of the cooking cycle. Rapid cooks, involving 6-hour cycles, might tend to accentuate these conditions.
6. Drafts or air currents.

It is only rarely that any one of these influences would be great enough to cause severe damage to a well-designed and constructed lining, since the possibility of such occurrences is taken into consideration in the design of a lining. It is, however, readily conceivable that a combination of conditions and careless operation might cause severe breakdown. For instance, an installation temperature of 100°F. would not be impossible, and a combination of other influences, such as a cold draft on a winter night following a "shutdown" period, might cause a reduction of the shell temperature to 125 or 120°F. or even less without appreciably affecting the face-brick temperature. In such a case the thermal expansion tendency of the face brick might be three or four times the expansion tendency of the shell, particularly at about the fourth or fifth hour of the cooking cycle. The resulting compression added to the residual stress would quite likely cause severe spalling. In this connection it is interesting to note that Jarlier in reviewing the conditions surrounding six digester explosions prior to 1928 discovered (*5*) that all six accidents occurred in the winter and that they took place at hours of the day when the temperature is lowest, either in the early morning or during the night.

The service life of a digester lining may be conservatively estimated at about 8 years at the present time. Under optimum operating conditions, with proper design to satisfy the particular operating conditions, continued care in the selection of materials, and with due observance of the precautions listed here, the average may be raised considerably. Very many linings have now been in service for well over 12 years with very little maintenance work over that period. Some linings have not required replacement in nearly 20 years.

For the average digester at present, the lining costs on this basis, and including any maintenance costs on the lining, do not exceed 12¢ per ton of pulp on the basis of present-day costs. Many digesters operate with a linings cost as low as 6¢ per ton of pulp and in exceptional cases with a lower cost. Only rarely do costs exceed 15¢ or approach 20¢ per ton of pulp.

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The author wishes to thank the St. Regis Paper Co. for their permission to take the temperature measurements on the digester at the Deferiet, N. Y., plant. In addition, the generous assistance and cooperation of T. Gerace and his staff at that plant were essential to the completion of the work.

Effect of Storage of Southern Pine on Pulp Yield and Quality

H. L. KEATON and W. F. GILLESPIE

Some operational and economic problems posed by wood storage in the south are discussed. Operational difficulties presented by wood storage are as follows: difficulties in handling easily removed bark, jamming conveyor sprockets and chains, excessive chipper fines, low yields, low tests, and changed black liquor characteristics. Comparison of dry-inventory wood which showed marked signs of decay was made with freshly cut green southern pine to determine the effects of prolonged storage on chipping and pulping characteristics and pulp quality. A 4-day mill run of 100% five months old, relatively dry inventory wood was made following the experimental cooks. The results found were in agreement with those from the experimental cooks.

Wood storage in the southern region presents certain operational and economic problems quite different from those encountered in the northern pulp producing sectors of the United States and Canada. Storage periods of 1 to 2 years are common in the north. Such prolonged storage in the south would result in a raw material that would be practically worthless. The ravages of fungi, stains, rots, animal life, and humidity exact a rapid and heavy toll on wood inventories in the south.

Fortunately, most of the wood is used very quickly after cutting—a matter of a few days. Weather conditions generally admit of low inventories. During the summer months a 10 to 12-day supply is usually considered adequate. During November and December inventories increase as a precaution against the difficulties of getting wood out during the rainy season of the early year. Inventories usually rise to at least a 30-day supply.

Economic turnover of this inventory becomes a serious management problem. The cost of turnover will vary depending on the efficiency of the methods employed. Prolonged storage means cheaper handling, but prolonged storage also causes decreases in yield and a lowering in quality. If the magnitude of these factors were a little more accurately known, it would be possible for management to improve its judgment on the effect of the time factor in wood storage.

It is the purpose of this paper to add to the knowledge of the effect of storage on the yields and pulp quality of stored wood. The inadequacy of the data to answer all important questions will be apparent to those faced with the problems.

LABORATORY INVESTIGATION

Difficulties in the handling of the easily removed bark; brittleness of small diameter logs that break and jam conveyors, sprockets, and chains; excessive sawdust; low yields; low tests; and changed black liquor characteristics are all operational problems presenting real difficulties to those in charge of production. Opinions on the magnitude of the effects may vary considerably. In the authors' mill good guesses were the only guide. In an effort to be more accurate a program was set up to study wood deteriorated by storage.

As is so often the case, the difficulties in selecting a proper sample presented a real problem. The authors know of no method to measure adequately the degree of decay. The Forest Products Laboratory at Madison is investigating the development of a decay factor and it is believed that such a contribution would be both useful and welcome.

The samples were selected by a group of operating and technical personnel who at least agreed that the type of wood investigated would fall in a class that could be considered as fairly representative of wood that contributed to the operational difficulties that are generally attributed to wood depreciated by storage.

The data reported herein were obtained on samples of a dry wood. Bolts were light and easily fractured. Bark had fallen off. It was stained, had suffered partial decay, and had evidence of insect attack. It is not possible to state the period between cutting and use, nor the exact conditions under which it was stored. Other types of defective wood; water logged, "cat faces," and mixtures were studied, but the results herein reported are considered by the authors to be representative of the most common type of partly deteriorated stored wood encountered by southern mills.

The bolts of wood selected for test were marked and barked through the drums and removed from the discharge conveyor. Each group of experimental bolts was stored and chipped separately and always after chipper knives had been changed. This eliminated variables in chipping caused by dull knives.

Chip screens were covered with board and all chips were collected for each type of wood.

Table I

Chip analysis from chipper	*Green wood*	*Dry inventory*
Retained on 1-inch screen, %	25.8	23.3
Retained on 1/2-inch screen, %	59.0	52.4
Retained on 1/4-inch screen, %	13.6	18.4
Through 1/4-inch screen, %	1.6	5.9
Chip analysis to experimental digester		
On 1/2-inch screen, %	81.3	74.0
On 1/4-inch screen, %	18.7	26.0
Moisture as chipped, %	49.8	31.9
Specific gravity	0.566	0.54
Pounds moisture-free wood per cubic foot	35.3	33.7

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Table II. Pulping Data

Cook No.	Concentration of active alkali charged (Na_2O) Per cent of dry wood	Concentration of active alkali charged (Na_2O) Grams per liter	Pulp yields Total (per cent of dry wood)	Pulp yields Screened (per cent of dry wood)	Screenings (per cent of total pulp)	TAPPI hardness No.
		Green pine—Digester charge 25 lb. moisture-free wood				
1	15	35.7	49.6	46.3	6.75	33.8
2	17	40.4	49.3	48.3	1.89	25.7
4	18	42.7	42.9	42.3	1.60	18.3
		Dry inventory pine—Digester charge 20 lb. moisture-free wood				
7	15	35.7	46.1	44.2	4.12	30.0
8	16.3	38.8	46.3	45.0	2.70	23.7
9	17	40.4	45.6	44.2	3.20	22.3

To eliminate variables in chip size in cooking, chips were screened on a laboratory screen and the fraction above 1 inch and below $^1/_4$ inch were eliminated. Those passing the 1 and $^1/_2$-inch mesh were used.

Moisture tests and specific gravity tests (TAPPI Standard T 18 m-47) were made immediately after chipping. The data obtained are shown in Table I.

These data show that in the chipping operation more fines are produced from the stored wood. If it is dry, it shatters badly and in these experiments it appears that 4.3% more of the wood is lost through the fine mesh screens to the fuel bins. In addition, the chips charged to the digester are somewhat finer.

The lower specific gravity of the inventory wood reflected itself in the digester charges made in the cooking experiments.

Cooking

The cooking was done in a 2.65 cubic foot digester using forced circulation and indirect heating. A 3-hour cooking cycle was used, 1 hour to 100 p.s.i. gage and 2 hours at this pressure. A liquid to wood ratio of 4.2 was maintained on all cooks, and the active alkali as Na_2O varied between 35.7 and 42.7 grams per liter as the active alkali varied from 15 to 18% based on the dry chips. The same cooking liquor was used throughout the cooks reported.

Normally 25 pounds of moisture-free chips are used in the cooking experiments. In our digester this allows sufficient space above the chips for liquor distribution and improves circulation. With the low density inventory wood and filling the digester to the same level, only 20 pounds of moisture-free wood could be put in the digester. That is, in the same volume there is 20% less moisture-free wood using the inventory wood. While we do not have exact data on a commercial digester, it is the authors' opinion that one cannot get as great an amount of moisture-free wood in the digester using stored wood. And in addition, if you fail to compensate for this decreased amount of wood, pulps that are softer and, consequently, of lower yield will result.

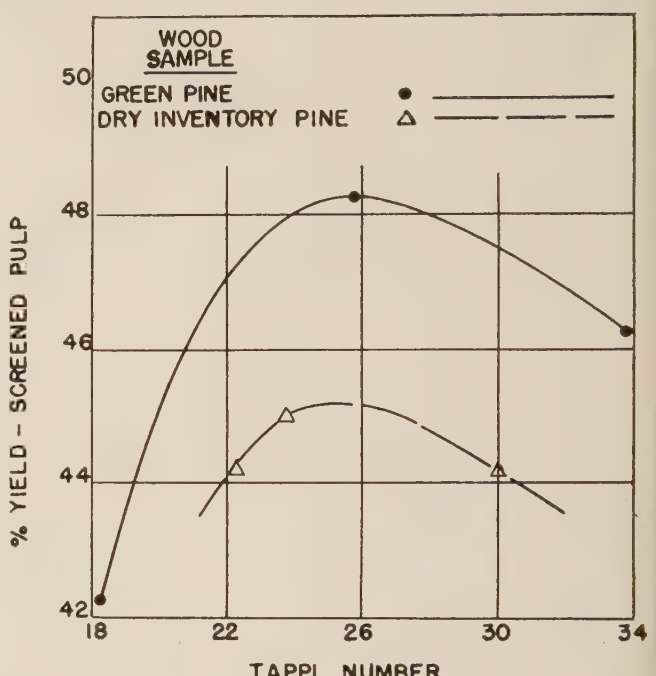

Fig. 1. Per cent yield screened pulp versus TAPPI number

The results of a series of cooks on two types of woods are given in Table II.

From Fig. 1 and Table II it is evident that at any TAPPI permanganate number selected the yield from the stored wood is less either as total pulp or screened pulp. A possible exception to this may be in the range of very soft pulps.

Pulp Quality

Pulp was prepared for testing by screening through a 0.012-inch cut laboratory screen. TAPPI standard

Table III. Pulp Quality—Comparison of Dry-Inventory Pine with Green Pine

Cook No.	Beating time, min. 0		15		30		40		50	
	2	8	2	8	2	8	2	8	2	8
	Cook No. 2—Green pine: Cook No. 8—Dry-inventory pine									
Active alkali as Na_2O, %	17.0	16.3	...	...	...	...	...	...	...	...
TAPPI hardness no.	25.7	23.7	...	...	...	...	...	...	...	...
Freeness-modified S.-R., ml.	762	768	689	731	350	631	160	434	83	215
Specific surface, sq. cm./g.	10,000	7300	12,900	9900	16,600	11,500	19,500	14,800	20,900	15,700
Basis weight, lb. (24 × 36—500)	39.4	41.1	42.4	41.7	41.2	40.4	40.6	40.5	40.9	41.4
Caliper, in.	0.00558	0.00567	0.00438	0.00419	0.00388	0.00365	0.00366	0.00357	0.00352	0.00343
Apparent density, g./cc.	0.451	0.464	0.618	0.637	0.678	0.711	0.708	0.726	0.742	0.775
Burst factor	20.8	18.8	56.7	50.3	66.2	63.2	72.9	69.2	73.9	70.4
Tear factor	228.5	194.5	155.3	121.7	120.0	99.4	112.5	98.0	97.0	91.0
Tensile, meters breaking length	3830	2810	8290	7430	9610	9000	9660	9820	10,100	10,200
Stretch, %	1.81	1.73	3.22	2.79	3.53	3.01	3.24	3.20	3.13	3.28

Table IV. Mill Tests

Experimental run										Av. values for previous 6 months					
					Bursting strength		Density					Bursting strength		Density	
Date	Shift	No. rolls	Basis weight, lb.	Caliper	lb.	lbs. per lb. basis wt.	g./cc.	lb./pt. caliper	Per cent below	Basis weight	Caliper	lb.	lbs. per lb. basis wt.	g./cc.	lb./pt. caliper
7–14–49	2–10	6	108.5	29.1	238	2.20	0.718	3.73	8.0	106	28.3	253.7	2.39	0.721	3.75
	10–6	7	109.3	29.2	249	2.28	0.721	3.75	4.6						
7–15–49	6–2	5	109.7	28.4	252	2.30	0.741	3.85	3.8						
	2–10	7	109.7	29.0	244	2.22	0.727	3.78	7.1						
	10–6	2	110.2	29.1	245	2.22	0.730	3.79	7.1						
			109.5	28.9	246	2.24	0.727	3.78	6.1						
7–16–49	6–2	4	59.1	15.3	142	2.41	0.745	3.87	8.0	59.4	15.8	155.8	2.62	0.721	3.75
	2–10	6	60.7	15.7	135	2.23	0.745	3.87	14.9						
	10–6	6	60.4	16.0	138	2.28	0.725	3.77	13.0						
7–17–49	6–2	6	60.5	15.6	142	2.34	0.745	3.87	10.7						
	2–10	5	60.3	15.8	139	2.30	0.735	3.82	12.2						
	10–6	2	61.2	15.9	139	2.28	0.741	3.85	13.0						
			60.4	15.7	139	2.31	0.739	3.84	11.9						

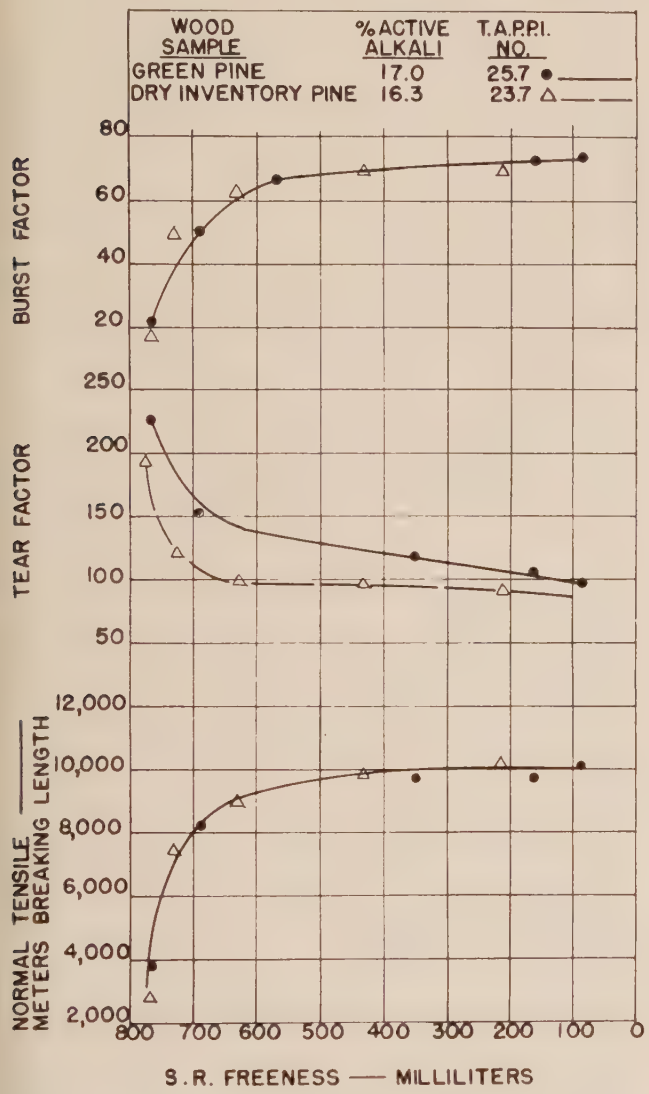

Fig. 2. Burst, tear, and tensile versus S.R. freeness

pulp preparation and sheetmaking procedures were followed except for the standard TAPPI sampling schedule.

Freeness (modified Schopper Riegler) and specific surface (*1*) were determined at each time interval.

Basis weight, caliper, apparent density, burst, tear, tensile, and stretch were determined on handsheets under standard humidity and temperature conditions (50% R. H. and 73 °F).

All results are shown in Table III.

The comparisons reported here are on the two pulps in the intermediate hardness range. Comparisons of the harder or softer pulp result in similar trends.

The results obtained on the strength characteristics are plotted: (1) strength against freeness (Fig. 2), and (2) strength against apparent density (Fig. 4). Figure 2 shows: (a) the burst factor on both pulps is approximately the same, (b) the normal tensile is about the same, and (c) the tear factor is higher on the green freshly cut pine.

This is completely in accord with an extensive unpublished study made some years ago by Goss and Aitkens of Gaylord Container Corp.

Figure 3 shows the relationship between apparent density and Schopper Riegler freeness and it is evident that over the whole range of beating the laboratory handsheets show a higher apparent density on the dry inventory wood.

Figure 4 shows the relationship between the strength properties and the apparent density. At every apparent density the normal tensile, burst, and tearing strength are greater on the green freshly cut pine.

In Table III and on Fig. 5 results on specific surface measurements are shown. Clark (*1*) advocates the use of this test as a measurement of fibrillation of pulp with refining. Green pine at any beating time or degree shows considerably greater specific surface. We believe the green pine pulp responds to beating to a greater extent and this may be a partial explanation of the development of greater strength.

MILL RUN

Following the laboratory investigation, a 4-day mill run of 100% five months old inventory wood was made. It was chiefly dry wood though considerable

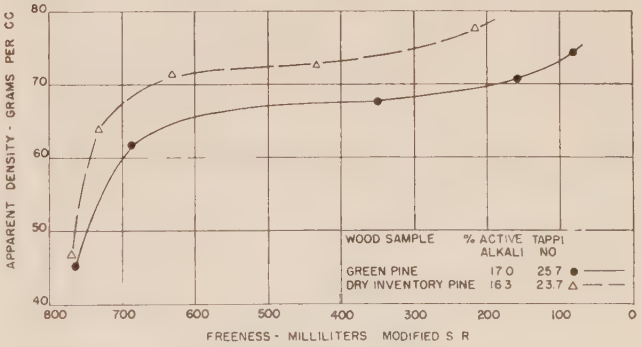

Fig. 3. Apparent density versus S.R. freeness

wet wood was encountered at the bottom of the piles used.

In our mill we have a slow running, four cylinder board machine which runs only on high test, solid kraft furnishes. Because of the relative ease with which variables can be controlled on this machine, we always use its production as a criterion of our pulp quality.

In Table IV results of all-kraft liners run on this machine during the test period are recorded and averaged. Also, the 6 months' average before this run is listed. The table shows: (a) a higher density sheet on solid kraft grades when using the dry inventory wood, and (b) a lower burst test on the dry wood in spite of its greater density.

Other machines in the mill showed the same tendencies on almost every grade but because of different furnishes, machine speeds, refining variables, etc., we could not always state with certainty that the lower tests obtained on the inventory wood could be attributed solely to the pulp quality. We are sure that the results are given in Table IV.

SUMMARY

On the basis of laboratory experiments and verified in part by mill runs, pine wood held in inventory until affected by partial decay will differ from freshly cut pine in the following manner:

1. Produce about 4% more fines under 1/4 inch size during chipping.
2. Approximately 20% less moisture-free wood can be packed in a given volume.
3. Has a lower specific gravity.
4. Pulp yields are decreased by about 3.3% screened pulp in intermediate pulp hardness ranges based on moisture-free wood.

Compared at the same apparent densities (0.65 grams per cc.) pulps produced from dry inventory wood when compared with comparable hardness pulps from green pine show:

5. (a) Approximately 15% lower burst factor, (b) approximately 25% lower tear factor, and (c) approximately 12% lower normal tensile strength.
6. Pulp from freshly cut pine develops a greater specific surface on beating.
7. Handsheets from dry-inventory pine wood pulp are denser than those from freshly cut pine wood pulp.

The authors believe that handsheets compared on an apparent density basis as advocated by Clark (*2*) will show a closer relation with machine-made paper than if the comparison is made on a freeness basis.

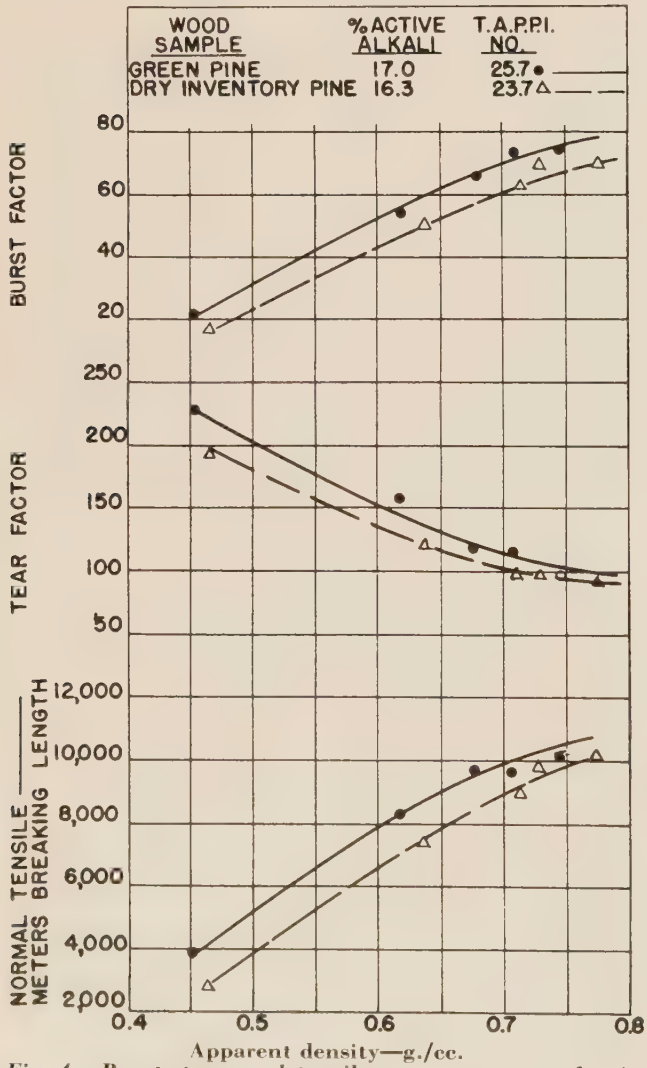

Fig. 4. Burst, tear, and tensile versus apparent density

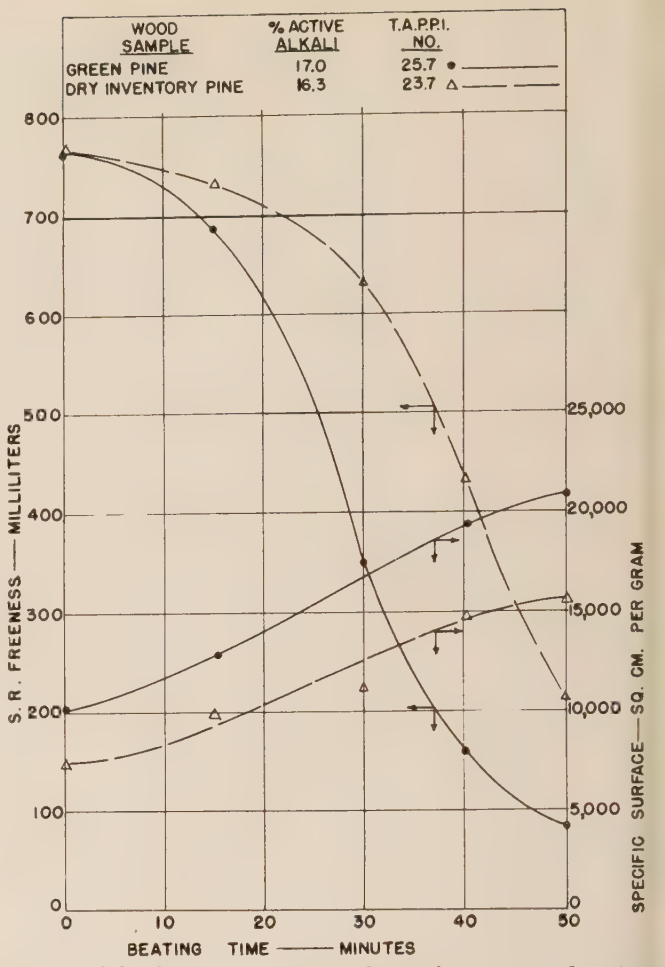

Fig. 5. S.R. freeness and specific surface versus beating time

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Control of Condensate Return Line Corrosion

WILLIAM A. TANZOLA

The perplexing problem of condensate return line corrosion is discussed from the standpoint of the basic factors that are involved and the mechanism of the corrosion reactions. The sources of the corrosive gases, oxygen and carbon dioxide, are outlined, and methods of removal of dissolved oxygen and reduction of carbon dioxide are presented both from the standpoint of mechanical changes that can be made to the condensate system and the external water treatment methods of the water that are possible. Complete elimination of carbon dioxide from condensate systems is not possible, and even small concentrations of this gas in solution can produce undesirable amounts of corrosion. The use of neutralizing types of amines for control of carbon dioxide corrosion are cited. The introduction of a new approach to the control of condensate corrosion through the use of filming type amines is discussed.

Corrosion in steam and condensate return lines and associated equipment is a problem that most plants encounter. The problem is usually quite severe and leads to frequent replacement of lines, valves, traps, etc. Not only are replacements due to failure frequently required, but replacements are necessary often solely due to plugging of the lines with corrosion products that originate at other parts of the system. The maintenance costs entailed by this problem frequently are high and if interruption of production is also a result, the costs become excessive.

Failures most frequently occur at threaded joints because the metal thicknesses have been reduced at these points. Horizontal lines are usually more severely attacked than vertical lines due to incomplete draining of the condensate in systems that operate intermittently. The corrosive action manifests itself in the form of grooving or channeling for the most part, although frequently pitting of the metal is also observed.

The principal causes for steam and condensate corrosion are the dissolved gases, carbon dioxide and oxygen. These gases must be in solution before they become aggressive. There are other influencing factors such as rate of condensation, time of contact, temperature, metal heterogeneity, galvanic action, and others but only because they supplement the basic factors.

The corrosion reaction for dissolved oxygen may be illustrated as follows:

$$4Fe + 6H_2O + 3O_2 \rightarrow 4Fe(OH)_3 \quad (1)$$

iron + water + oxygen → ferric hydroxide

The ferric hydroxide formed may later revert to iron oxide rust as follows:

$$2Fe(OH)_3 \rightarrow Fe_2O_3 + 3H_2O \quad (2)$$

ferric hydroxide → iron oxide + water

When carbon dioxide dissolves in water it forms carbonic acid which is a weak acid and produces corrosion in keeping with the following equation:

$$Fe + 2H_2CO_3 \rightarrow Fe(HCO_3)_2 + H_2 \quad (3)$$

iron + carbonic acid → ferrous bicarbonate + hydrogen

The above reaction proceeds rapidly at pH values below 5.9. The reaction product, ferrous bicarbonate, tends to elevate the pH and as the pH increases above 5.9, the reaction rate becomes reduced. The hydrogen formed in the reaction will also have a retarding effect particularly when the pH exceeds 5.9.

The ferrous bicarbonate formed in this reaction is soluble and can be carried along in the condensate. However, at points of pressure drop or reduced carbon dioxide content in the vapor phase it will precipitate from solution in keeping with the following reaction:

$$Fe(HCO_3)_2 \rightarrow FeO + 2CO_2 + H_2O \quad (4)$$

ferrous bicarbonate → ferrous oxide + carbon dioxide + water

When dissolved oxygen is also present, it will influence the reaction rate by removing the hydrogen to form water. The ferrous bicarbonate will precipitate as follows:

$$2Fe(HCO_3)_2 + {}^1/_2O_2 \rightarrow Fe_2O_3 + 4CO_2 + 2H_2O \quad (5)$$

ferrous bicarbonate + oxygen → ferric oxide + carbon dioxide + water

A combination of reactions 4 and 5 can be written to show the production of Fe_3O_4, the magnetic oxide of iron as illustrated by equation 6.

$$3Fe(HCO_3)_2 + {}^1/_2O_2 \rightarrow Fe_3O_4 + 6CO_2 + 3H_2O \quad (6)$$

ferrous bicarbonate + oxygen → magnetite + carbon dioxide + water

In some cases, the decomposition of ferrous bicarbonate has resulted in the production of deposits of ferrous carbonate:

$$Fe(HCO_3)_2 \rightarrow FeCO_3 + CO_2 + H_2O \quad (7)$$

ferrous bicarbonate → ferrous carbonate + carbon dioxide + water

From the above reactions, it can be seen that deposits of FeO, Fe_2O_3, Fe_3O_4, $FeCO_3$, and mixtures of these can be found present in steam and condensate systems and are the type deposits usually responsible for plugging.

Oxygen in steam and condensate systems may originate directly from the boiler feedwater or may enter at various points in the condensate system. Oxygen is present in most make-up waters and unless the make-up water is brought to saturation temperature in a properly vented open or deaerating heater, appreciable amounts will remain in the feedwater entering the boilers. When the feedwater is subjected to boiler temperature the oxygen will be released and a portion of it can be entrained with the steam and find its way into the condensate system. Oxygen that enters in this fashion can be coped with readily by use of mechanical or chemical deaeration of the feedwater.

In vacuum return systems or in gravity-type return systems there is ample opportunity for oxygen infiltration. While condensate that is returned under pres-

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sure will usually be free of oxygen, infiltration can take place where such systems operate intermittently.

It is not uncommon for cooling water to be injected into the vacuum pumps to lower the temperature of the condensate. This practice is also followed in certain gravity-type return systems where the condensate is collected in a centrally located receiving tank for pumping back to the boiler plant. The cooling water is usually laden with oxygen, and its introduction into the condensate generally creates a corrosion problem that manifests itself in the form of pitting. Where cooling water must be added, it should be controlled thermostatically so that the amount introduced is held to an absolute minimum. To avoid corrosion from the introduction of cooling water, catalyzed sodium sulphite, which permits rapid reaction of the sulphite with oxygen in the cold, can be proportioned to the cooling water to react with the oxygen and eliminate it from the water.

Vented condensate receivers are often a source of oxygen infiltration and through changes in the physical arrangement, oxygen infiltration can be prevented. Figure 1 illustrates this point.

In general, the elimination of oxygen from condensate systems can be accomplished through relatively simple means and for this reason corrosion and pitting due to dissolved oxygen are readily controlled.

Carbon dioxide is the usual cause of steam and return-line corrosion, and the corrosion is characterized by a general thinning of the pipe wall or grooving along the bottom of the pipe.

The chief source of carbon dioxide is the bicarbonate and carbonate alkalinity of the make-up water to the boilers. The bicarbonate and carbonate alkalinity when subjected to boiler temperature undergo thermal decomposition and liberate carbon dioxide which becomes entrained with the steam. The decomposition is illustrated by the following equations:

$$2HCO^-_3 + \text{heat} \rightarrow CO_3^{--} + CO_2 + H_2O \quad (8)$$

bicarbonate + heat → carbonate + carbon dioxide + water

$$CO_3^{--} + H_2O + \text{heat} \rightarrow 2OH^- + CO_2 \quad (9)$$

carbonate + water + heat → hydroxide + carbon dioxide

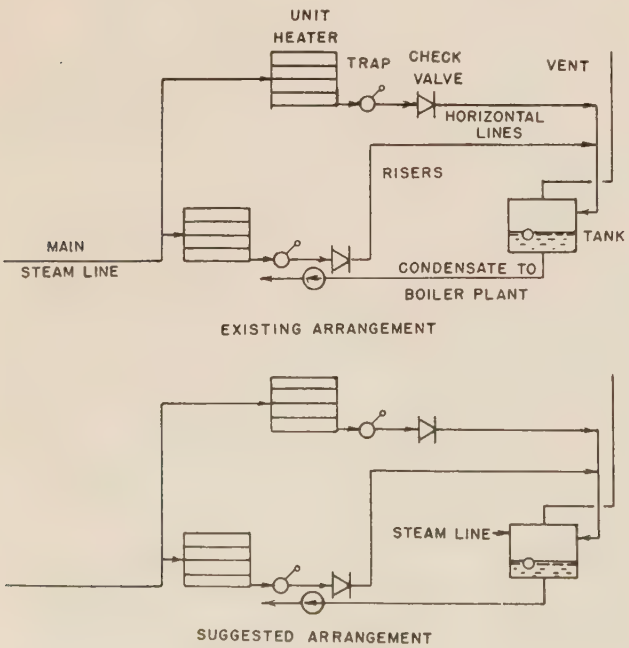

Fig. 1. Air infiltration

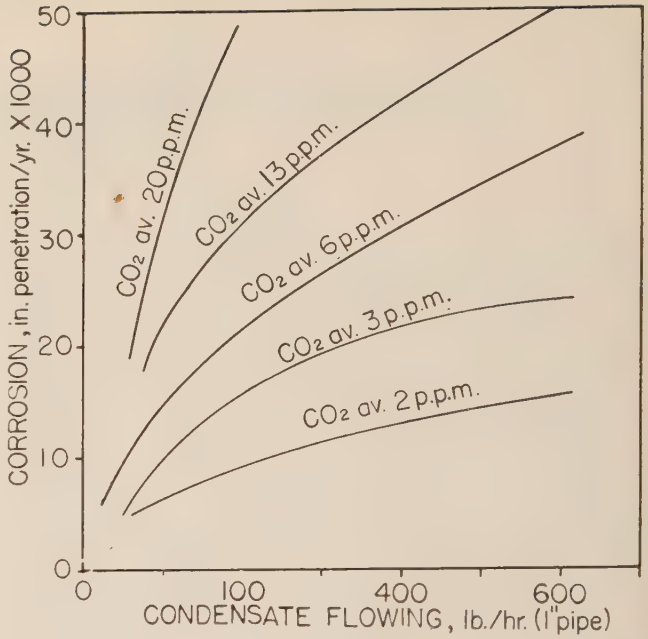

Fig. 2. Corrosion vs. condensate flow

Reaction 8 proceeds to 100% completion whereas reaction 9 is only partially complete with decomposition taking place to approximately 80%. Based on these reactions it can be calculated that for each 1 p.p.m. of bicarbonate alkalinity (expressed as calcium carbonate), in the boiler feedwater, 0.79 p.p.m. of carbon dioxide will be evolved. For each 1 p.p.m. of carbonate alkalinity (expressed as calcium carbonate) 0.35 p.p.m. of carbon dioxide will be evolved.

The other possible and usually minor sources of carbon dioxide are the free, gaseous carbon dioxide that is dissolved in most natural waters and the carbon dioxide which forms from decomposition of soda ash that may be used for regulation of boiler water alkalinity. Free carbon dioxide is almost completely eliminated by efficient feedwater deaeration and consequently is rarely a factor in steam and condensate corrosion. The use of soda ash is inadvisable where return-line corrosion is being experienced and should be replaced by caustic soda.

CORROSIVE EFFECTS OF CARBON DIOXIDE

The curves illustrated by Fig. 2 show that, other conditions being fixed, corrosion is proportional to the carbon dioxide concentration of condensates. It will be noted that at carbon dioxide concentrations of 2 p.p.m. or less, negligible corrosion results, and that, in general, concentrations of carbon dioxide up to 5 p.p.m. will not produce serious corrosion.

Even at low carbon dioxide concentrations, however, corrosion can take place at isolated points in the condensate system. For example, the curve of Fig. 2 shows that for any one concentration of carbon dioxide, the rate of corrosion increases with the quantity of condensate flowing or, in other words, corrosion is a function of the total pounds of carbon dioxide. Therefore, in a given system corrosion may only be a serious problem where the quantity of condensate handled is high, such as in the main return line.

In order for carbon dioxide to be corrosive it must be in solution. The laws of Henry and Dalton govern the solution of gases in liquids and state in simple form that

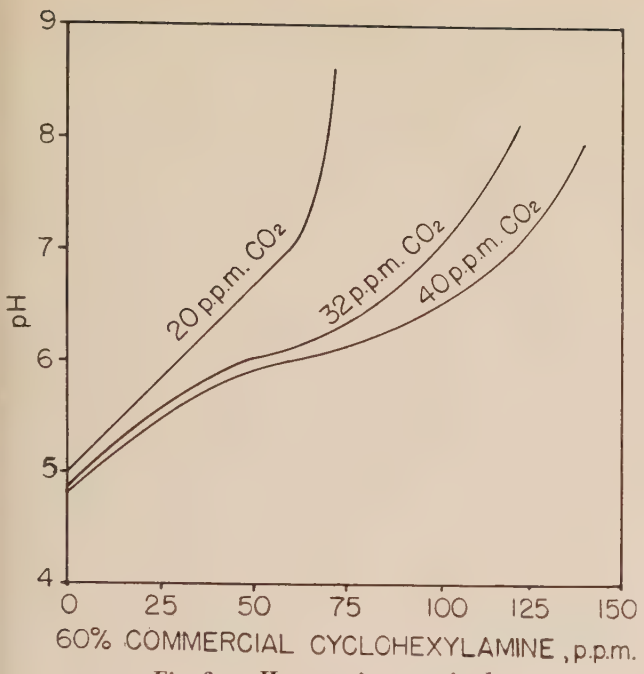

Fig. 3. pH vs. amine required

the concentration of a gas dissolved in a liquid is proportional to its partial pressure (or concentration) in the contacting gaseous phase. The application of these laws serves to explain severe corrosion that occurs in units condensing steam that operate intermittently. For example, when a drier or unit heater is first supplied with steam and condensation occurs the resulting condensate will have a negligible amount of carbon dioxide dissolved in it, because the partial pressure of the carbon dioxide in the vapor phase is low. Assuming that the incoming steam contains 20 p.p.m. of carbon dioxide, the initial condensate discharged by the unit will have less than a fraction of 1 p.p.m. The remaining carbon dioxide will accumulate in the vapor phase above the condensate in the unit. As condensation continues the accumulated carbon dioxide will develop a partial pressure sufficiently high to permit resolution of more and more carbon dioxide until equilibrium is attained under which condition the carbon dioxide content of discharged condensate will equal that of the incoming steam. It can be calculated that the quantity of carbon dioxide that must accumulate in the gaseous phase will be in the range of several hundred to more than a thousand parts per million before equilibrium conditions are attained. If such units operate intermittently, on cooling and as pressure on the unit decreases, considerable quantities of carbon dioxide will go into solution. The pH of the condensate will be lowered and accelerated corrosion will take place. It is apparent, therefore, that corrosion in isolated units can take place even though the concentration of carbon dioxide in the steam is relatively low. Because of the accumulation of carbon dioxide that is possible, venting of the units continuously during operation or shortly before shutdown would prove of material benefit. It is also essential that such units be provided with proper drainage.

REDUCTION OF CARBON DIOXIDE CONTENT OF STEAM

From the foregoing considerations it is apparent that it is advisable to reduce the carbon dioxide content of the steam to as low a value as possible. Since the bicarbonate and carbonate alkalinity of the make-up water are the chief source of carbon dioxide, methods of reducing the carbon dioxide content of the steam involve reduction of the alkalinity of the make-up water. There are various methods of external conditioning that will accomplish the desired reduction of alkalinity.

The lime soda or lime gypsum method of softening will bring about a reduction of alkalinity to a range of 50 or 60 p.p.m., and the residual alkalinity will be principally in the form of carbonate alkalinity. In controlling the softeners of this type, it is advisable to maintain the alkalinity of the effluent in the form of carbonate and hydrate rather than in the form of bicarbonate-carbonate. At the range of alkalinity normally maintained, the expected carbon dioxide content of the steam will be on the order of 17 to 21 p.p.m. when employing 100% make-up.

Zeolite softeners operated on the sodium cycle do not alter the bicarbonate alkalinity of the raw water. To reduce the bicarbonate alkalinity of the raw water, treatment of the softener effluent with acid to lower the bicarbonate alkalinity to a range of approximately 5 to 10 p.p.m. has been practiced. Following acid treatment, the water is aerated to expel the carbon dioxide produced and then deaerated. Special feeding equipment, piping, and materials of construction are necessary particularly for the deaerating heater when neutralizing alkalinity to this relatively low range. Combination sodium-hydrogen zeolite softeners will produce similar results.

With the zeolite-acid treatment method it has been possible to reduce the carbon dioxide content of steam to values of 5 p.p.m. and lower. At this level of carbon dioxide, corrosion generally will not be serious. While it is possible to reduce corrosion to a tolerable level by external treatment, complete elimination of corrosion by this means alone is not possible.

NEUTRALIZING AMINES

It is possible to bring about elevation of the pH value of steam by neutralizing the carbonic acid with alkaline materials and thus reduce corrosion. Inorganic salts

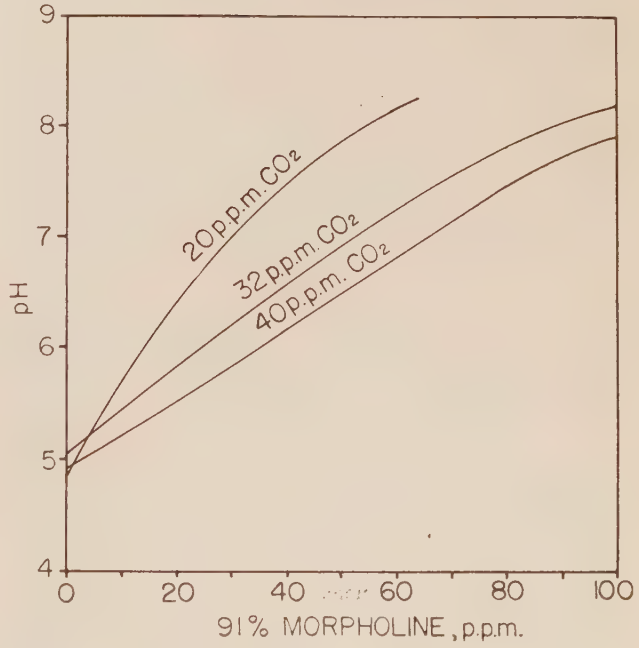

Fig. 4. pH vs. amine required

Table I. Typical Test Specimen Data—Oil Refinery

Time of exposure	Weight loss, mg.	Average penetration, inches per year
Before treatment		
2 weeks	962	0.0652
2 weeks	657	0.0445
4 weeks	1487	0.0493
4 weeks	1002	0.0342
Specimens exposed 2 weeks after treatment started		
2 weeks	85	0.0058
2 weeks	91	0.0062
4 weeks	195	0.0066
4 weeks	195	0.0066

Table II. Typical Test Specimen Data—Chemical Plant

Time of exposure	Weight loss, mg.	Average penetration, inches per year
Before treatment		
2 weeks	503	0.0342
2 weeks	694	0.0472
4 weeks	766	0.0260
4 weeks	723	0.0245
Specimens exposed 2 weeks after treatment started		
2 weeks	27	0.0018
2 weeks	60	0.0041
2 weeks	17	0.0011
2 weeks	24	0.0016

such as ammonium sulphate have been used for this purpose. These salts when subjected to boiler temperature will evolve ammonia gas which will be entrained with the steam. At points of condensation the ammonia will become soluble and neutralize the acidity imparted by carbonic acid. While a reduction in corrosion of ferrous metals can be brought about by this method, copper and zinc-bearing metals are seriously corroded particularly when oxygen is also present. Because of the serious attack on nonferrous metals the use of inorganic ammonium salts or ammonia itself should be avoided.

Neutralization of carbonic acid can safely be accomplished by certain volatile amines such as cyclohexylamine, $C_6H_{11}NH_2$, and morpholine, C_4H_9NO. These amines when fed to a boiler volatilize with the steam and combine with the carbon dioxide in the condensate to neutralize its acidity. Unlike ammonia the amines in low concentrations are not corrosive to copper and zinc-bearing metals. Control of treatment is usually based on feeding sufficient amine to raise the pH of the condensate to 7.0. Satisfactory reduction of carbon dioxide corrosion is obtained with the use of the neutralizing amines in the absence of oxygen.

Figures 3 and 4 illustrate the relationship of the quantity of amine necessary to elevate the pH value of condensates for various concentrations of carbon dioxide. It will be noted that on the average approximately 1.6 p.p.m. of morpholine and 3.0 p.p.m. of cyclohexylamine (commercial product—60% active ingredient) are necessary per part of carbon dioxide to elevate the pH to 7.0.

There are two chief disadvantages attendant to the use of the neutralizing amines. The first disadvantage is that these materials provide no protection against oxygen attack. While oxygen is seldom present in the steam in modern plants, many plants do encounter air leakage into the return system, and use of the neutralizing amines will not prevent corrosion under such conditions.

The second disadvantage of the neutralizing amines is the high cost of treatment. Since these materials function by neutralizing the acidity of carbonic acid where high concentrations of carbon dioxide are present relatively high amounts of the amine are necessary.

FILMING TYPE AMINES

A new principle in the prevention of return-line corrosion is based on the deposition of a film of long-chain polar amines on the metal surfaces. The filming

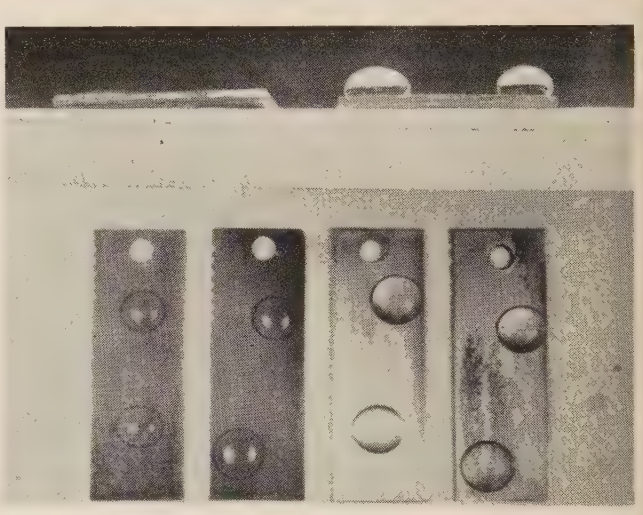

Fig. 5. Top, and Fig. 6, bottom. Action of water on an untreated (top, left) and treated metals

amines function on a new and completely different principle from the neutralizing amines. The filming amines do not neutralize carbon dioxide. Instead, they function by forming on the metal surfaces contacted and impervious nonwettable film that acts as a barrier between the metal and the condensate, protecting against both oxygen and carbon dioxide attack. When the filming amines are adsorbed on a metal surface, water will not wet that surface. The film formed through the

Table III. Test Specimen Data Showing Increased Protection over a 5-Month Period

Test conditions	Time of exposure, weeks	Building No. 2		Combined returns	
		Weight loss, mg.	Average penetration, inches per year	Weight loss, mg.	Average penetration, inches per year
Before treatment	2	30	0.0020	369	0.0250
	2	19	0.0013	443	0.0300
	4	43	0.0015	600	0.0203
	4	20	0.0010	629	0.0213
Treatment started 2 weeks before specimens exposed	2	2	0.0001	114	0.0078
	2	4	0.0003	124	0.0084
	4	2	0.0001	234	0.0080
	4	3	0.0001	238	0.0081
Specimens exposed after 5 months of treatment	2	2	0.0001	5	0.0003
	2	4	0.0003	4	0.0003
	4	7	0.0002	3	0.0001
	4	8	0.0003	1	0.0000

Table IV. Test Specimen Data from Plants of Varying Operating Characteristics

Plant	Operating pressure, p.s.i.g.	Steam production, lb./day	CO_2 in steam, p.p.m.	Average penetration, inches/year Before treatment	After treatment	Protection, %
A	400	700,000	23	0.0300	0.0060	80
B	250	500,000	21	0.0222	0.0018	92
C	125	1,500,000	30	0.0082	0.0016	80
D	110	400,000	30	0.0241	0.0002	99
E	335	550,000	14	0.0308	0.0021	94
F	300	2,000,000	49	0.0483	0.0062	87
G	150	450,000	75	0.0032	0.0005	84

use of these amines is of substantially monomolecular thickness and does not increase in thickness with continued treatment. The amine will penetrate corrosion products present on a metal surface and deposit a protective film on the metal. While continuous treatment is advised, the adsorbed film on the metal surface is quite durable and is not removed during short periods of discontinued treatment.

Figure 5 is a photograph of two test specimens on which a few drops of water have been placed. The specimen on the right has been exposed to condensate treated with the filming amines and it can be noted how the amine film causes the water to assume droplet form. The untreated specimen on the left does not repel water and the water spreads over the surface.

Figure 6 shows two steel specimens on the left and two brass specimens on the right after 30 days' exposure in a plant condensate system treated with filming amines. The water repellency of the specimens is shown by the spherical form assumed by the drops of water.

The filming amines of value in the prevention of corrosion are the high molecular weight amines and amine salts having straight carbon chains containing 10 to 18 carbon atoms. Octadecylamine ($C_{18}H_{37}NH_2$), hexadecylamine ($C_{16}H_{33}NH_2$), and dioctadecylamine ($C_{36}H_{74}NH$) are examples of the most useful materials of this type. In plant practice the most successful results have been obtained with the dispersed octadecylamine.

Permacol is the trade name of the commercial dispersion of octadecylamine in which the insoluble amine is processed and emulsified so that dispersion and feeding from water solutions are possible. This dispersed form of the filming amine is applied to steam and return-line corrosion problems by feeding the material with a small chemical pump to the main steam line at a point where it will be well mixed with the steam. The material is readily dispersed with the steam and is carried through the steam and condensate lines forming a nonwettable film on the metal surfaces contacted.

Unlike the neutralizing amines which must be fed in direct proportion to the carbon dioxide concentration of the steam, a feeding rate of 15 to 30 p.p.m. of the commercially dispersed filming amine is usually sufficient to establish and maintain the desired corrosion-resistant film on the metal surfaces. Consequently, except at low carbon dioxide concentrations the filming amine treatment is considerably more economical than the use of the neutralizing type amines.

Extensive data have been accumulated on this new approach to corrosion control in condensate systems both in pilot plant work and in over 50 full-scale plant applications. Evaluation of plant results secured with the filming amines has been made through careful records of maintenance and line replacement costs and also from data secured by exposure of test strips at representative points in the condensate system. In general practice, test strips have been exposed in duplicate over 2- and 4-week intervals, both before and after applying treatment.

Usually, test specimen data have shown an immediate marked reduction in the corrosion rate with the application of the filming amines. Tables I and II illustrate the prompt reduction in corrosion at two different plants with specimens exposed only two weeks after the treatment was started. In each case a reduction of approximately 90% in the corrosion rate was obtained.

The data contained in Table III are particularly interesting since the increased protection secured over a period of time is shown. As can be noted, the corrosion rate for building No. 2 was not excessive even before treatment. The filming amine reached this point in the system quite quickly and promptly reduced the corrosion rate to a negligible value. Tests conducted 5 months later showed essentially the same results. The corrosion rate was so low as to be barely measurable.

Specimens exposed on the combined returns as delivered back to the boiler room showed a high corrosion rate prior to treatment. The steam and condensate systems at this plant are quite extensive and while an immediate improvement was noted in first applying the filming amines, the full effects of treatment are noted on the samples exposed five months later. Immediate results were secured at building No. 2 since this point was close to the power plant. The specimens exposed in the combined returns probably did not receive the full benefit of the filming amine treatment until all of the long lines acquired an amine film. Undoubtedly, since the system was badly corroded some amine was also adsorbed by iron oxide deposits until gradually all the surfaces became saturated. The 99% reduction in corrosion shown by these data is quite impressive and is confirmed by plant maintenance records showing that pipe failures and replacements have been eliminated. The low corrosion rates on the combined returns were secured even with oxygen present in the condensate at this point due to air infiltration.

A summary of data obtained from plants of varying operating characteristics is shown by Table IV. It will be noted that the protection secured ranged from 80 to 99%. The corrosion rate is not directly proportional in each case to the carbon dioxide concentration of the steam because of factors such as flow rate, temperature, oxygen concentration, etc., which varied in each individual case. However, both before and after treatment the test specimens were exposed at the same point in the system and under the same operating conditions.

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The Effect of Certain Latex Variables in Beater Addition of Nitrile Rubber Latices

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A number of nitrile rubber latex variables have been studied to determine their effect on beater impregnation. The work was limited to latices prepared with one basic polymerization system, and to a medium beaten Scandinavian unbleached kraft pulp. The results of this study indicate that a rubber of medium acrylonitrile content and molecular weight, and with no additional stabilization after polymerization will give optimum properties. When alum was used as the coagulating agent, optimum properties were obtained at a final pH range of 4.5 to 5.5. Coagulation may be carried out with either dry alum or alum solution. Somewhat better properties were obtained by coagulating with a 100–20 mixture of alum-sodium hydroxide at a final pH of 5.5 to 6.5. Coagulation with acids and acid-alum mixtures as well as final pH values much above 6.5 are to be avoided as these conditions cause sticky sheets. Vulcanization of the latex after coagulation appears to give a beneficial effect, but this is more than offset by the losses in properties brought about by the extra stabilizer that must be added along with the curing ingredients. Plasticizers for the latex improved drape and softness of the sheet, but at the expense of strength. Both stretch and edge tear were increased roughly as a straight-line function of the amount of latex added, while tearing strength progressively decreased. Bursting strength increased to a maximum, while tensile tended to decrease. Dilution of the latex from 30.7 to 3.6% before addition to the pulp did not appreciably change the properties when the pulp concentration remained constant.

THE term "latex" was originally applied to aqueous dispersions of rubber obtained from a number of plants, with practically all of the latex used commercially being obtained from the tree known botanically as *Hevea Brasiliensis*. This material is an important item of commerce and is usually specified as hevea latex, natural latex, or natural rubber latex. With the advent of synthetic rubbers and resins prepared by emulsion polymerization, the meaning of the term "latex" has been broadened. Because of their similarity in appearance and colloidal properties to hevea latex, the aqueous dispersions of resins and rubbers produced by emulsion polymerization are also designated as latices.

Natural rubber is a versatile and valuable product, and no synthetic rubber has been found that is a satisfactory substitute for it in all applications. However, for many end uses synthetic rubbers have been developed which are superior to natural rubber. Although the quality of natural rubber may vary due to methods of collecting and processing, the basic polymer cannot be appreciably altered. Synthetic rubber, on the other hand, can be varied to give a range of products of widely different properties so that it may be possible to "tailor make" a synthetic rubber to meet the requirements of a particular use. Economically, synthetic rubbers offer a source of uniform product not subject to the wide price fluctuations inherent in natural products.

The synthetic rubbers of commercial importance are as follows:

Butadiene-Styrene Polymers—These materials are produced as GR-S by the Government and, of the synthetics, most nearly approach natural rubber in general utility. They are available as latex.

Chloroprene Polymers—This type of rubber, usually called neoprene, was the first synthetic rubber commercially available in this country. It is characterized by medium to good oil resistance and is available in latex form.

Butadiene-Acrylonitrile Polymers—These materials are generally known as Buna N or Nitrile rubber. They are characterized by excellent oil resistance and are available in latex form. Latices of this class were used in this investigation.

Isobutylene-Isoprene Polymers—These materials—butyl rubbers—have excellent resistance to the passage of gases. They are not produced by emulsion polymerization, but aqueous dispersions of the rubber have been prepared.

A number of early investigators found hevea latex to be of interest in impregnating various fibrous materials, but it was not until the work of Kaye in the early 1920's that serious consideration was given to the incorporation of latex into paper at the beater. Kaye (*1*) found that addition of 0.5 to 5.0% latex solids to beaten pulp, followed by coagulation with acid or alum, would give improved strength without appreciably changing the appearance of the paper.

When larger amounts of latex were used (*2*), the tensile strength was increased to a maximum point, beyond which it declined. Largest percentage improvements were realized with weaker sheets such as those heavily loaded and those made from waste paper.

In recent years, considerable interest has been directed toward the addition of synthetic rubber to pulp in the beater. However, the literature on this subject is somewhat meager. Owens (*3*) studied the effect of styrene-butadiene ratio of Buna S latices upon properties when the latices were incorporated into pulp in the beater. A polymer of 40 styrene, 60 butadiene gave optimum edge tear and stretch. The results obtained with a polymer of this ratio are considerably better than those obtained with natural rubber.

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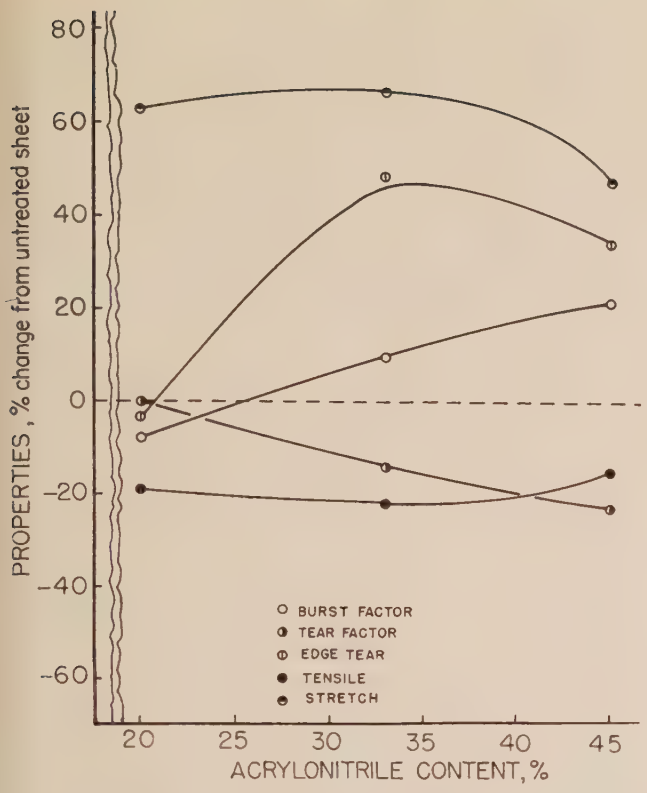

Fig. 1. Effect of acrylonitrile content of rubber upon sheet properties

This Owens attributes to a superior type of bonding exhibited by the co-polymer.

Walsh, Abernethy, Pockman, Galloway, and Hartsfield (*4*) found the addition of 1 to 5 parts solids of a sensitized polychloroprene latex to pulp in the beater to give sheets of better wet strength. Larger amounts of latex (15 to 50 parts) gave products with leatherlike properties.

Oliner and O'Neil (*5*) compared properties obtained by adding a nitrile rubber latex in the beater to a beaten, high alpha pulp to those obtained by impregnating a saturating paper with the same latex. Beater impregnation gave much greater bursting strength, tensile strength, stiffness, and density and somewhat greater tearing strength but lower stretch than sheet saturation.

Preliminary field evaluation of commercially available nitrile rubber latices indicated that materials from different sources, though quite similar in butadiene-acrylonitrile content, gave appreciably different results in beater impregnation. It therefore appeared worthwhile to investigate the effect of latex variables upon beater impregnation.

VARIABLES STUDIED

The variables included in this study fall into three classes and include (1) those involved in the manufacture of the latex, (2) those involved in compounding the latex, and (3) those involved in incorporating the latex into the pulp.

Nitrile Rubber Variables

A brief review of the process for manufacturing nitrile rubber latex will indicate the possible uariables.

A typical reactor charge will contain the following ingredients: butadiene, acrylonitrile, water, emulsifier, catalyst, and modifier. The water, emulsifier, and catalyst are charged to the reactor, followed by the butadiene and acrylonitrile under pressure. The jacketed kettle is heated until the exothermic reaction gets underway, at which time cooling water is used to regulate the reaction temperature. The mixture is continually agitated by means of a stirrer to give uniform temperature. After a typical reaction time of 12 hours at 30 to 50°C., the reaction is terminated by the addition of a "short stop," the residual monomers stripped out, and stabilizing agents may be added. Antioxidant to protect the rubber may also be added as an aqueous dispersion.

The following discussion of polymerization variables indicates those which are important in determining the properties of the rubber.

Monomer Ratio. Monomer charging ratios for nitrile rubbers normally vary from 85 to 15 to 55 to 45 butadiene-acrylonitrile. The acrylonitrile content of the final co-polymer is controlled not only by the initial charging ratio, but also by the degree of conversion of the co-polymer, because of different polymerization rates of the two monomers. Increasing acrylonitrile content in the polymer increases strength properties but decreases elongation. Oil resistance increases with increasing acrylonitrile content, as does the brittle point temperature.

In preparing the latices used in this study, butadiene-acrylonitrile charging ratios of 80 to 20 to 55 to 45 were used. Polymers prepared with less than 20% acrylonitrile content are deficient in strength and oil resistance, while those prepared with more than 45% acrylonitrile in the charge are deficient in elongation and flexibility.

Latex Solids. Latex solids are controlled by the monomer-water ratio in the initial charge and by the degree of conversion of the polymer. Commercially available latices are produced having final solids content varying from 30 to 55%. In order to get this variation in latex solids, it is also necessary to vary soap content and particle size of the latex.

All of the latices used in this study were prepared at approximately 30% solids. In the study on the effect of latex solids, a latex prepared at 30.7% solids was diluted with water to the desired solids content.

Type and Amount of Emulsifier. The emulsifier plays a very important role in emulsion polymerization. Not only does it keep the monomers and polymer in suspension but it is instrumental in initiating the reaction. The current theory of emulsion polymerization is that polymerization is initiated at emulsifier micelles into which catalyst radicals enter. As polymerization proceeds, monomer in the dispersed droplets is dissolved in water and finds its way to the polymer nucleus which grows into a polymer latex particle until all of the monomers are used up or the reaction terminated. Soaps of the fatty acid and rosin acid types, and synthetic surface-active agents of the alkyl sulphate and aryl alkyl sulphonate types are normally used as emulsifying agents.

The emulsifying agent used during polymerization gives sufficient stability to prevent coagulation during the reaction. However, the surface of the latex particle is not completely saturated with emulsifying agent.

In order to insure adequate stability of the latex for compounding, additional surface-active agent may be added after the completion of polymerization.

All of the latices used in this study were made with the same emulsifying system. Ammonium oleate was used in the study of the effect of adding soap after completion of the reaction.

Particle Size. The particle size of commercially available acrylonitrile rubber latices varies from 600 to 3000 A. The particle size is controlled by the amount of soap used in initiating the reactions and other polymerization variables. If a large amount of soap is used, there will be many active centers and many small particles will be produced. If a small amount of soap is used, there will be fewer active centers, resulting in fewer but larger particles.

The effect of particle size was not included in this study. All of the latices used had a particle size in the range of 1200 to 1500 A.

Catalyst. Oxidizing agents, such as hydrogen peroxide and potassium persulphate, are used to initiate the polymerization reaction. Variations in catalyst type are not known to have any effect on the way the polymer is built up.

Modifier. To regulate chain length, a polymerization modifier or regulator is used. Some of the higher mercaptans have been found useful for this purpose. With small amounts of modifier, long chain length materials that are tough and have high "nerve" are produced. With large amounts of modifier, short chain length materials that are soft and plasticlike are produced.

The rubber industry uses a plasticity measurement which measures the flow of rubber under heat and pressure to give an indication of its chain length. The Mooney plasticity measurement used on materials included in this study gives increasing readings with increasing chain length. The small rotor was used, therefore, the results are designated as Mooney (M/S).

Commercially available nitrile rubbers vary in Mooney (M/S) from 30 to 80. The Mooney (M/S) of the rubber in the latices included in this study varied from 15 to 88.

Short Stop. A polymerization reaction may be carried until all of the monomers are consumed, or it may be terminated by use of a "short stop." Reducing agents, such as hydroquinone, are often used for this purpose. Some short stopping agents are more effective than others in their completeness of terminating the reaction. This variable was not included in these studies.

Antioxidant

Both natural and synthetic rubbers contain a great deal of unsaturation and are, therefore, subject to oxidation. Although some uses for latex do not require the addition of an antioxidant, the use of antioxidant is considered good practice. Unfortunately, the best antioxidant from a protection standpoint (phenyl beta naphthylamine) tends to discolor upon aging. On the other hand, some of the antioxidants which do not discolor are deficient in protective qualities for nitrile rubbers. All of the latices used in this study contained 1% on the weight of the rubber solids of an alkylated diphenylamine. This antioxidant gives fairly good protection with only moderate discoloration.

Compounding Variables

The properties of a rubber or rubber latex may be considerably altered by compounding. The following compounding variables were studied.

Cure. The strength of rubber is greatly increased by vulcanization to give cross linking between the chains. Sulphur, along with other ingredients, is usually used for this purpose. The rubber in latex may be vulcanized either before or after it is coagulated. Both approaches were used in the study on the effect of cure. In all other studies, no curing ingredients were included in the latex.

Plasticizer. Nitrile rubbers may be modified or plasticized by the addition of certain liquids to give greatly increased elongation and softness. Dibutyl phthalate, which is one of the better plasticizers for nitrile rubber, was used in the study on the effect of plasticizer.

Variables of Incorporating Latex into Pulp

The effect of the method used for coagulating the latex and the effect of the amount of latex used were studied.

Coagulating Agent. Rubber latices prepared with anion-active emulsifying agent—as were those used in this study—may be coagulated by the use of polyvalent metal ions, the establishments of acid conditions, or a combination of the two. All of these methods were investigated.

Amount of Latex. The amount of latex solids added was varied from 10 to 50 parts per 100 parts of pulp.

EXPERIMENTAL PROCEDURES

A Scandinavian unbleached kraft pulp (Korsnas)

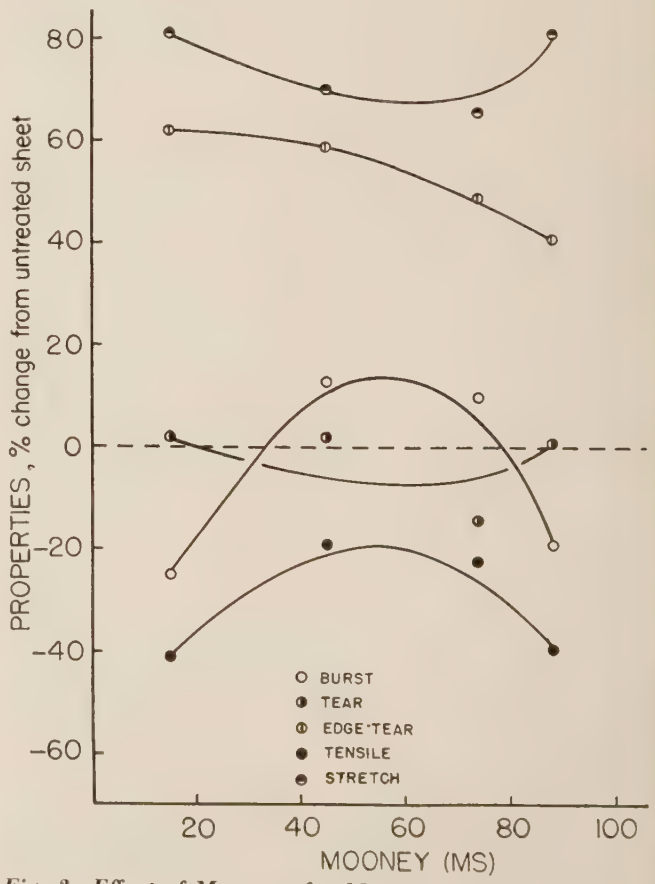

Fig. 2. Effect of Mooney of rubber upon sheet properties

made from coniferous wood was used in these studies. Unless otherwise noted, beating was carried out at 3% consistency in a Noble and Wood laboratory beater using 80 pounds on the beater arm and a beating time of 15 minutes. This gave a beaten pulp with a Canadian freeness of about 630 ml.

Latex was added to the beaten pulp and, after mixing, the coagulating agent added to bring the water to the desired pH. Handsheets were made on Noble and Wood sheetmaking equipment. Sheets of 40 pounds basis weight (24 × 36—500) were used and sheets were pressed to 37.5% solids content before drying.

Moisture-free pulp (1430 grams) was used as the beater charge and this was more pulp than was needed for handsheets in studying a given variable. In the study of latex variables it was necessary to prepare many special laboratory samples of latex at considerable cost and it was desirable to conserve this latex as much as possible. Cleaning and furnishing the beater after each experiment were also rather time consuming when one considers that over 500 beater runs were made in this study. Therefore, it was desirable to use smaller amounts than a beater batch for each experiment. It was found that portions of the beaten pulp could be treated with latex and coagulating agent in a bucket to give results comparable to those obtained when the additions were made to pulp in the beater. The procedure evolved consisted of withdrawing enough beaten pulp to give 66 grams of dry pulp and placing it in a bucket. While the pulp was agitated with a "Lightnin" mixer, enough latex was added to give the desired amount of latex solids. After the pulp and latex had been mixed for 1 minute, enough coagulating agent was added to bring the pH to the desired value. pH was determined colorimetrically. The pulp-latex mixture was then stirred for 5 additional minutes and handsheets prepared.

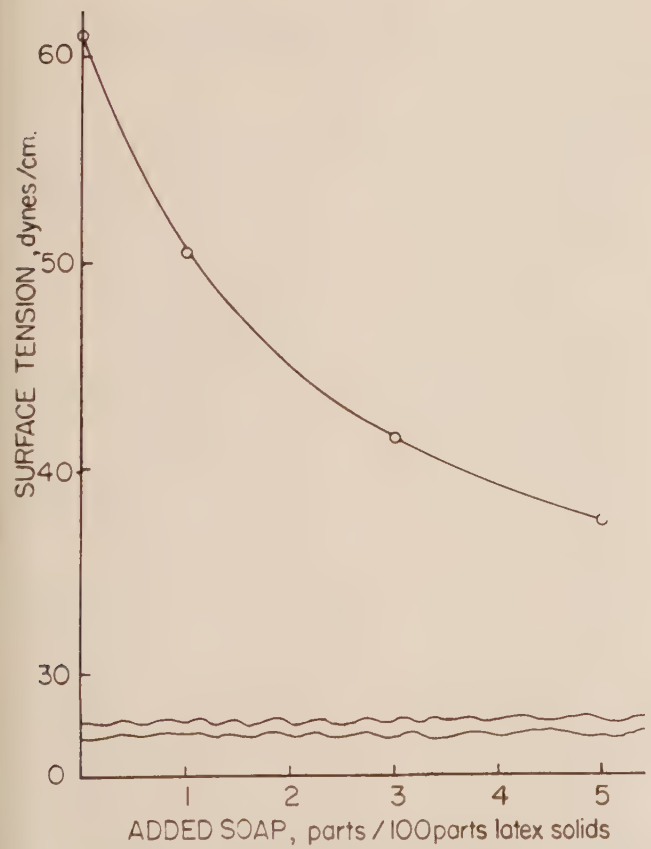

Fig. 3. Effect of added soap upon surface tension of latex

Unless otherwise specified, the latex-pulp mixtures made in these studies were prepared in a gallon bucket using the following proportions of materials:

Pulp	66 grams (moisture-free)
Latex	33 grams (solids)
Coagulating agent	Papermaker's alum, added as a 10% solution
Final pH in bucket	4.5

The proportions of latex solids and dry alum given in the tables were obtained by calculating to a basis of 100 parts of moisture-free pulp.

The following TAPPI methods were used for evaluating the hand sheets:

Conditioning before testing	T 402 m-44
Basis weight	T 410 m-45
Bursting strength	T 403 m-43

The results are reported as burst factor, which is defined as follows:

$$\text{Burst factor} = \frac{\text{Bursting strength in p.s.i.} \times 100}{\text{Basis weight}}$$

Tearing strength ..... T 414 m-42

The results are reported as tear factor, which is defined as follows:

$$\text{Tear factor} = \frac{\text{Tearing strength in grams} \times 100}{\text{Basis weight}}$$

Edge tear	T 470 sm-45
Tensile breaking strength	T 404 m-47
Stretch	T 457 m-46
Stiffness	T 451 m-45
Folding endurance	T 423 m-45

NITRILE RUBBER VARIABLES

Effect of Acrylonitrile Content of Rubber

From an economical standpoint it would be desirable to use the lowest acrylonitrile content rubber practical, as acrylonitrile is about three times as expensive as butadiene. On the other hand, higher acrylonitrile polymers may be more efficient because of greater strength properties and greater polarity. Three latices were prepared that were similar in all respects with the exception that the butadiene-acrylonitrile charging ratios were 80–20, 67–33, and 55–45. Results obtained on sheets containing the latices are given in Table I and Fig. 1.

Table I. Effect of Acrylonitrile Content of Rubber

Latex, parts	0	50	50	50
B/A charging ratio	...	80/20	67/33	55/45
Added soap, parts	...	0	0	0
Surface tension, dynes per cm.	...	60.8	61.1	55.8
Solids, %	...	31.2	28.5	29.7
pH	...	11.2	11.0	10.7
Mooney, (M/S)	...	60	74	74
Alum, parts	5.0	6.7	7.6	6.5
Burst factor	88	85	97	107
Tear factor	275	274	236	211
Edge tear, lb.	6.3	6.5	9.4	8.5
Tensile strength, lb.	24.1	19.4	18.7	20.4
Stretch, %	2.7	4.4	4.5	4.0
Folding endurance, no.	83	130	273	657

All of the rubbers greatly increased the stretch of

the sheet with the high acrylonitrile content material being somewhat less effective. All of the rubbers improved the folding endurance of the sheet, with the improvement increasing rapidly as the acrylonitrile content increased. The low acrylonitrile content rubber had little effect on edge tear but the other two rubbers gave substantial improvements with optimum values in the middle acrylonitrile content range. Addition of the low acrylonitrile content rubber had little or no effect on bursting and tearing strengths but increasing the acrylonitrile content of the rubber gave a progressive increase in bursting strength and a progressive decrease in tearing strength. All of the rubbers reduced tensile strength with little or no trend indicated.

These results indicate that optimum over-all properties are obtained by using a rubber of medium acrylonitrile content, except where maximum oil resistance and maximum folding endurance are required, in which case the higher acrylonitrile content rubber should be used.

The Effect of Mooney Plasticity of Rubber

The Mooney plasticity measures the flow of the rubber under the action of heat and pressure. It gives an indication of the workability of the rubber and is an indirect measurement of the molecular weight of the material. Rubbers of very high Mooney are "nervy" and dry, while rubbers of very low Mooney are soft and sticky.

Four latices were prepared which were similar in all respects with the exception that the modifier content used in polymerization was varied, so that the Mooney (M/S) was varied from 15 to 88. Results obtained on sheets containing these latices are given in Table II and Fig. 2.

Table II. Effect of Mooney of Rubber

Latex, parts	0	50	50	50	50
Mooney (M/S)	...	15	45	74	88
B/A charging ratio	...	67/33	67/33	67/33	67/33
Added soap, parts	...	0	0	0	0
Surface tension, dynes per cm.	...	61.7	61.3	61.1	58.9
Solids, %	...	35.8	28.2	28.5	32.8
pH	...	11.7	11.1	11.0	11.1
Alum, parts	5.0	6.7	6.5	7.6	6.7
Burst factor	88	66	99	97	71
Tear factor	275	281	282	236	279
Edge tear, lb.	6.3	10.5	10.0	9.4	8.9
Tensile strength, lb.	24.1	14.1	19.6	18.7	14.8
Stretch, %	2.7	4.9	4.6	4.5	4.9
Folding endurance, no.	83	26	123	273	228

All of the rubbers greatly increased stretch with the very low and very high Mooney rubbers being more efficient. The very low Mooney rubber was detrimental to folding endurance, but the other polymers gave large improvements with the greatest improvement coming with the 74 Mooney material. All of the materials greatly improved edge tear with the improvement decreasing as the Mooney value increased. All of the rubbers were detrimental to tensile strength with those in the medium Mooney range giving the least decrease. Rubbers in the medium Mooney range gave bursting strength greater than the sheet containing no latex while the low, and high Mooney rubbers gave bursting strength values less than the control. Tearing strength seems to be independent of the Mooney of the rubber.

These results indicate that optimum properties are obtained with rubber of medium Mooney values.

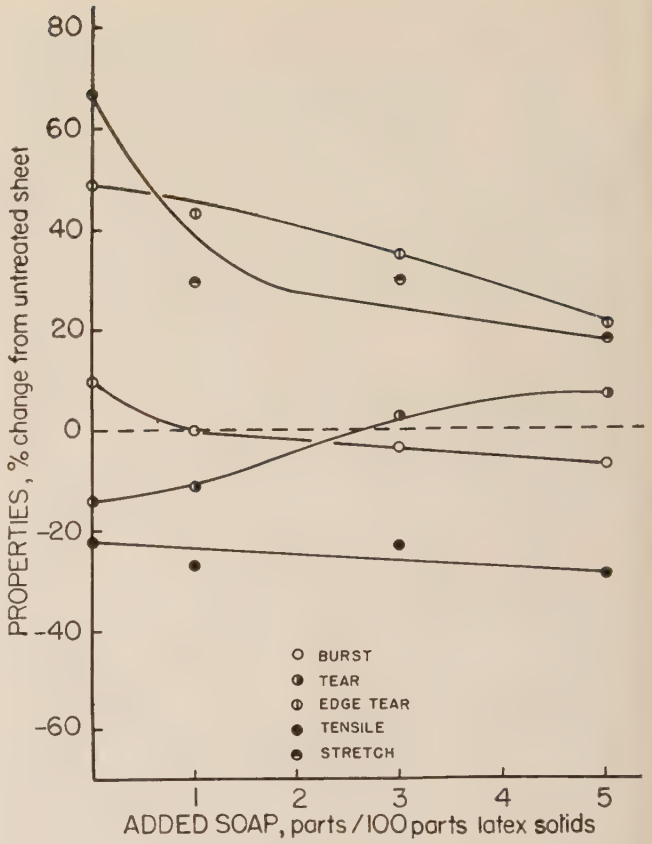

Fig 4. Effect of added soap upon sheet properties

Effect of Added Soap

The emulsifying agents used during polymerization do not completely saturate the surface of the latex particles. Since this is the case, the addition of progressive amounts of soap to the latex will bring about a lowering of surface tension, until the surface of the particle and the aqueous phase are both saturated with soap, at which time the surface tension will change very little upon the addition of more soap.

Figure 3 shows the effect of added soap upon the surface tension of the latex used in this study. When an increment of soap is added to a latex whose surface is not completely saturated, the major portion of the soap is apparently adsorbed on the surface of the latex particles, with a very minor amount staying in the water to lower the surface tension.

Upon coagulation of the latex with alum, the soap present in the latex is probably converted to insoluble aluminum soap which may have an influence upon the properties of the sheet.

One, three, and five parts of ammonium oleate (on the weight of the rubber) were added to latex after it was discharged from the reactor. Results obtained on sheets containing these latices are given in Table III and Fig. 4.

Stretch, edge tear, folding endurance, and bursting strength were all adversely effected by the addition of

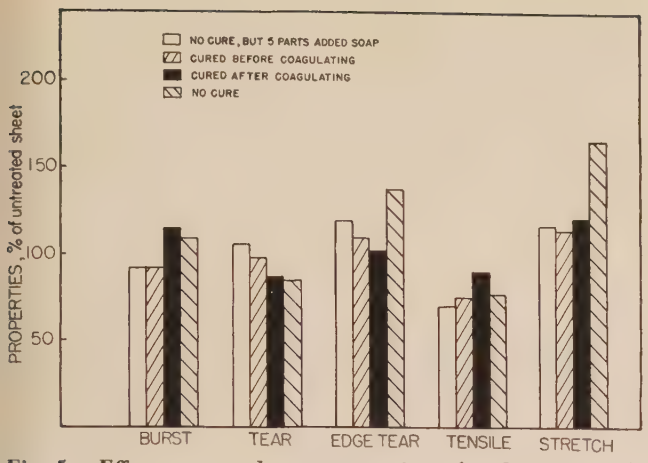

Fig. 5. Effect upon sheet properties of vulcanizing the rubber

soap—especially the first 1%. Tearing strength was improved by the addition of soap, while tensile strength was only slightly lowered.

Table III. Effect of Added Soap

Latex, parts	0	50	50	50	50
Added soap, parts	...	0	1	3	5
Surface tension, dynes per cm.	...	61.1	50.5	41.5	37.4
B/A charging ratio	...	67/33	67/33	67/33	67/33
Mooney (M/S)	...	74	74	74	74
Solids	...	28.5	28.6	28.3	28.1
pH	...	11.0	10.4	10.1	10.0
Alum, parts	5.0	7.6	6.5	6.8	6.8
Burst factor	88	97	88	85	82
Tear factor	275	236	247	284	295
Edge tear, lb.	6.3	9.4	9.0	8.5	7.6
Tensile strength, lb.	24.1	18.7	17.6	18.6	17.1
Stretch, %	2.7	4.5	3.5	3.5	3.2
Folding endurance, no.	83	273	181	126	58

These results indicate that for best results in beater impregnation, soap should not be added to the latex after completion of the reaction.

For the remainder of the studies reported here, a latex was used which was developed from the data reported above. Typical characteristics of this material, which is known commercially as Chemigum latex 245B, are given in Table IV.

Table IV. Typical Properties of Chemigum Latex 245-B

Approximate monomer ratio (butadiene/acrylonitrile)	67/33
Particle size, A	1250
pH	10.0
Surface tension, dynes/cm.	55
Viscosity, cp.	35
Film Mooney, small rotor	50
Specific gravity (dried solids)	0.98
Antioxidant	nonstaining
Color	white
Ash content	1% maximum
Weight per gallon, lb.	8.3
Total solids, %	32
Solids per gallon, lb.	2.6

COMPOUNDING VARIABLES

Effect of Vulcanizing the Latex

Vulcanization of nitrile rubber increases the tensile strength and stiffness and lowers the stretch. The rubber of the latex may be vulcanized either before or after it is coagulated. Both methods were evaluated.

To vulcanize the latex before coagulation, latex, well stabilized by the addition of soap, casein, and caustic was heated to 180°F. on a water bath. To this latex an aqueous dispersion containing 2 parts of sulfur, 3 parts of zinc oxide, and 1 part of an accelerator (tetra methyl thiuram monosulphide) per 100 parts of latex solids were added. The mixture was kept at 180°F. for 1 hour with constant gentle agitation to vulcanize the latex.

To prepare the latex compound to be vulcanized after coagulating, latex was well stabilized by the addition of soaps and casein solution. An aqueous dispersion containing 2 parts of sulphur, 4 parts of zinc oxide, and 3 parts of a fast accelerator (Setsit No. 5) were then added with stirring. Sheets prepared with the compounded latex were subjected to various curing times in an oven at 250°F.

Results obtained on sheets containing these latices are given in Table V and Fig. 5.

As it was necessary to use additional soap in compounding the curing latices, their surface tensions were reduced to the range of that of the uncompounded latex containing 5 parts of added soap. Therefore, the results of that latex are included in Table V for comparison.

The prevulcanized latex gave results quite comparable to those obtained with uncompounded latex containing 5 parts of soap. These sheets were, therefore, deficient in stretch and edge tear compared to those prepared with uncompounded latex containing no added soap.

The samples prepared from the compounded latex and well cured after coagulation gave tearing and bursting strength values similar to the sample containing uncompounded latex with no added soap. The tensile strength was slightly higher, but the edge tear and stretch were lower.

Vulcanization of the latex after coagulation appears to give a beneficial effect, but this is more than offset by the losses in properties brought about by the extra

Table V. Effect of Vulcanization

Latex, parts	0	50	50	50	50	50	50	50	50
Type latex	...	Uncompounded	Uncompounded	Prevulcanized	Compounded	Compounded	Compounded	Compounded	Compounded
Added soap, parts	...	0	5	5	5.5	5.5	5.5	5.5	5.5
Surface tension, dynes per cm.	...	61.1	37.4	39.3	35.8	35.8	35.8	35.8	35.8
Cure time at 250°F.	...	...	...	...	0	5	10	15	30
Alum, parts	5.0	7.6	6.8	5.0	5.7	5.7	5.7	5.7	5.7
Burst factor	88	97	82	82	85	86	94	97	102
Tear factor	275	236	295	272	291	259	261	253	241
Edge tear, lb.	6.3	9.4	7.6	7.0	7.5	6.7	7.2	6.4	6.5
Tensile strength, lb.	24.1	18.7	17.1	18.6	19.5	19.8	19.0	20.3	21.9
Stretch, %	2.7	4.5	3.2	3.1	3.1	3.2	3.2	3.2	3.3

Table VI. Effect of Adding Plasticizer for the Latex

Latex, parts	0	50	50	50	50[a]	50
Dibutyl phthalate, parts	0	0	5	10	20	20[b]
Alum, parts	4.6	8.0	7.6	7.6	7.6	7.6
Burst factor	84	91	74	58	39	41
Tear factor	295	248	304	347	306	277
Edge tear, lb.	6.5	9.0	9.2	8.2	6.4	6.0
Tensile strength, lb.	18.4	15.0	10.8	11.1	7.5	9.1
Stretch, %	2.1	3.8	2.9	2.6	3.1	2.7
Stiffness, cm.^{3}/100	101	40	34	30	18	19

[a] Sheets tended to stick to press felt.
[b] Plasticizer and latex heated together.

stabilizer that must be added along with the curing ingredients.

Effect of Plasticizing the Latex

Addition of plasticizer to nitrile rubber increases stretch, flexibility, and softness and reduces tensile strength. To determine whether plasticizing the latex would give more desirable properties to beater impregnated sheets, various amounts of plasticizer were added to the latex. Dibutyl phthalate, which is one of the better plasticizers for nitrile rubber, was used. The plasticizer was added to the latex as a 50% aqueous dispersion immediately before the latex was added to the pulp, with one exception. In that case the plasticizer dispersion and the latex were heated together for 30 minutes at 180°F. in order to drive the plasticizer into the latex particle. This plasticized latex was then cooled before adding to the pulp.

Results on sheets containing plasticized latices are given in Table VI and Fig. 6.

Incorporation of plasticizer into the latex gave more drape and greater softness as measured by hand feel. Tearing strength was also improved. However, addition of plasticizer was detrimental to bursting strength, tensile strength, stretch, and edge tear. Heating the plasticizer-latex mixture prior to adding to the pulp gave, roughly, the same results obtained without heating.

Except in those cases where maximum flexibility is required, the use of plasticizer is not indicated.

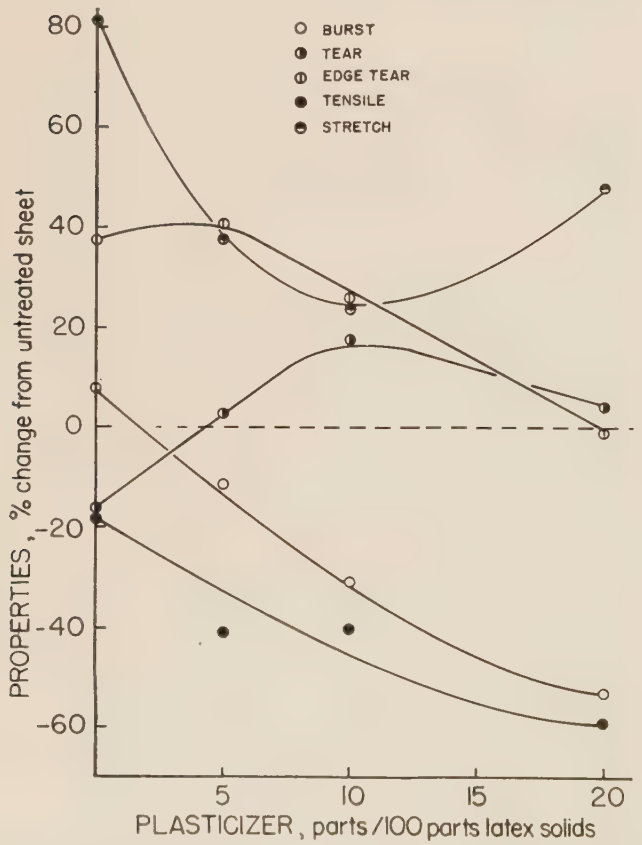

Fig. 6. Effect upon sheet properties of plasticizing the rubber

VARIABLES OF INCORPORATING LATEX INTO PULP

Effect of Coagulating the Latex

Unless the latex solids are coagulated on to the pulp fibers, much of the latex may be lost, and there is great likelihood that the papermaking system would become badly contaminated. In Table VII results on sheets to which no alum was added are compared to sheets in which alum was used.

These results show that without the addition of a coagulating agent, full benefit is not obtained from the latex added. It, therefore, appears advisable to add a coagulating agent for the latex.

Effect of Type of Coagulating Agent

Many coagulating systems are used in the production of dry rubber from latex. The particular system used will depend on the characteristics of the emulsifying agent present in the latex and on the properties desired in the coagulated rubber. Latices containing anion-active surface-active agents are usually coagulated by the use of polyvalent metal ions, the establishment of low pH conditions, or a combination of the two.

A number of coagulation systems were included in this study.

Effect of Coagulating with Alum. Alum is an efficient coagulating agent for alkaline colloidal systems because it reduces the pH and provides trivalent metal ions. A number of runs were made to determine the effect of changing the pH by adding various amounts of alum. The sheets made from the mixture with a pH of 6.5 tended to stick to the press felt so that a high pH was not tried. The sample with a pH of 4.0 was obtained by using twice the amount of alum needed for obtaining the pH of 4.5 so that a large excess of alum was probably present. In order to determine the relative merits of adding dry alum as compared to 10% alum solution, dry alum was used in one run to bring the pH to 4.5.

Test results are given in Table VIII and Fig. 7.

Table VII. Effect of Adding Alum to Coagulate the Latex

Latex, parts	0	50	50
Alum, parts	5.0	7.9	0
Final pH	4.5	4.5	...
Burst factor	88	97	66
Tear factor	275	236	278
Edge tear, lb.	6.3	9.4	9.3
Tensile strength, lb.	24.1	18.7	13.8
Stretch, %	2.7	4.5	3.8

Table VIII. Effect of Changing Final pH with Alum

Latex, parts	0	50	50[a]	50	50	50[b]
Alum, parts	4.6	16.7	8.3	8.0	5.5	3.5
Final pH	4.5	4.0	4.5	4.5	5.3	6.5
Burst factor	84	84	97	91	91	80
Tear factor	295	226	227	248	254	243
Edge tear, lb.	6.4	9.1	9.3	9.0	7.9	8.5
Tensile strength, lb.	18.4	12.3	15.0	15.0	13.3	13.0
Stretch, %	2.1	3.8	3.2	3.8	3.5	4.1

[a] Alum added as solid; added as 10% solution in other runs.
[b] Tended to stick to press felt.

Although results were somewhat erratic, stretch and tearing strength appeared to be relatively insensitive to final pH. Edge tear, bursting, and tensile strengths, on the other hand, were increased by reducing pH. To obtain optimum properties, a final pH of 4.5 to 5.5 was indicated. A pH above 6.5 is to be avoided, not only because of poorer strength properties, but also because the sheet tends to be sticky.

Addition of dry alum produced coagulation in a manner similar to that obtained with 10% alum solution. With the exception of somewhat lower stretch, the sample coagulated with dry alum gave properties almost identical to those obtained with alum solutions.

Effect of Coagulating with Alum-Sodium Hydroxide Mixtures. The results above indicated that when alum is used as the coagulating agent, best results are obtained if enough alum is added to bring the pH in the range of 4.5. To determine whether these results were due to the amount of alum present or to the pH, a series was run in which the amount of alum used was held constant, and the pH varied by adding various amounts of sodium hydroxide to the alum. In the sample to which no sodium hydroxide was added, 7.6 parts of alum were required to reduce to 4.5 the pH of a mixture containing 50 parts of latex per 100 parts of pulp. In the samples in which alum and sodium hydroxide were used together, the amount of alum used was held constant at 7.6 and the sodium hydroxide varied. This gave mixtures having different final pH values depending upon the amount of sodium hydroxide used. Test results are given in Table IX, Fig. 7.

Keeping the amount of alum constant and varying the pH by adding sodium hydroxide gave higher values in stretch, edge tear, tensile and bursting strengths at pH values of 5.3 and 6.9 than at 4.5. Figure 7 also shows that substantial improvements in these properties were obtained by using alum and sodium hydroxide mixtures over those obtained by using alum alone.

These results suggested a series of experiments in which the various final pH values were obtained by the use of different alum-sodium hydroxide mixtures.

A series of runs were made in which final pH values

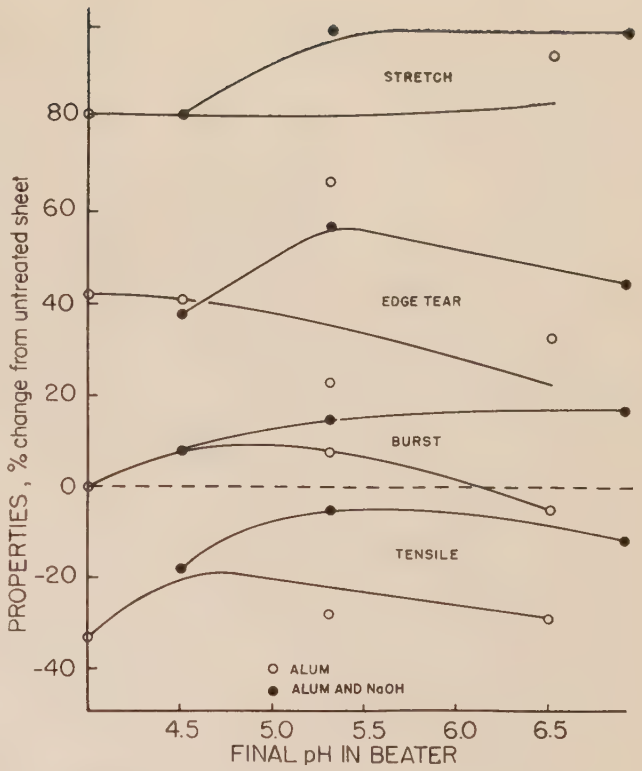

Fig. 7. Effect upon sheet properties of coagulating with alum and alum to which sodium hydroxide was added

of 4.5, 5.5, and 6.5 were obtained with alum, and alum/sodium hydroxide mixtures in the ratio of 100 to 10 and 100 to 20. In these experiments, technical grade aluminum sulphate ($Al_2(SO_4)_3$ $18H_2O$) was used instead of commercial papermakers alum, as was used in all other experiments. The results obtained are given in Table X and Fig. 8.

The results using alum alone reported in Table X are much less erratic than those given in Table VIII, but the same trends are indicated. As pH was reduced by the addition of alum there were improvements in all properties, with the data of Table X indicating more improvement in stretch than was previously indicated.

When alum-sodium hydroxide mixtures were used, the results were somewhat different. As the pH was reduced from 6.5 to 4.5 with these mixtures, there was an improvement in bursting strength, little change in tensile and tearing strengths, but substantial losses in stretch and edge tear.

These results indicate that better all-around properties—and especially high values for stretch and edge tear—may be obtained by coagulating with alum-NaOH mixtures in the 5.5 to 6.5 pH range.

Effect of Coagulating with Sodium Silico Fluoride.

Table IX. Effect of Coagulating with Alum to Which Various Amounts of NaOH Were Added

Latex, parts	0	50	50	50	50	50
Coagulating agent[a]						
Alum/NaOH ratio	100/0	100/0	100/10	100/20	100/30[b]	100/40[b]
Alum, parts	4.6	7.6	7.6	7.6	7.6	7.6
NaOH, parts	0	0	0.76	1.52	2.28	3.04
Final pH	4.5	4.5	5.3	6.9	7.6	7.6
Burst factor	84	91	97	98	53	49
Tear factor	295	248	228	235	273	280
Edge tear, lb.	6.5	9.0	10.2	9.4	8.1	7.5
Tensile strength, lb.	18.4	15.0	17.4	16.1	9.1	7.1
Stretch, %	2.1	3.8	4.2	4.2	3.6	3.3

[a] Alum and NaOH mixed as 10% solutions.
[b] Took 8 minutes for water to begin clearing after alum-NaOH added. Sheet splintery.

Table X. Effect of Coagulating with Alum-NaOH Mixture to Given pH Values

Coagulating system[a]										
Aluminum sulfate, parts	2.8	4.7	3.7	3.0	14.8	5.4	3.3	21.1	9.2	3.9
Sodium hydroxide, parts	0	0	0	0	1.50	0.57	0.33	4.23	1.83	0.77
Latex, parts	0	50	50	50	50	50	50	50	50	50
Final pH	4.5	4.5	5.5	6.5	4.5	5.5	6.5	4.5	5.5	6.5
Burst factor	72	86	75	76	86	72	71	81	73	72
Tear factor	309	302	282	285	269	279	270	273	262	281
Edge tear, lb.	6.9	8.4	8.6	8.2	8.8	7.9	10.2	8.2	8.6	9.5
Tensile strength, lb.	18.0	11.5	9.7	8.4	9.6	10.0	10.1	11.1	11.2	9.3
Stretch, %	2.1	5.1	4.7	3.9	4.4	4.9	5.0	4.5	4.6	6.3

[a] Mixed as 10% solution.

In the production of foamed rubber, sodium silico fluoride is used as a coagulating agent, because of its delayed action due to its limited solubility (about 1%) in water. Sodium silico fluoride is added to foamed rubber as an aqueous dispersion. As it is added to a large volume of water, some of the dispersed salt dissolves and hydrolyzes to give hydrofluoric acid. As the acid is neutralized by ammonia in the water, more of the dispersion dissolves. This gradual freeing of acid neutralizes the alkalinity of foamed rubber and brings about the desired coagulating effect. It was thought that such a delayed action may be desirable in coagulating latex in the beater in production equipment in order to allow thorough mixing of the coagulating agent with the latex before it started its action.

To 100 parts of pulp containing 50 parts of latex solids, various amounts of sodium silico fluoride was added as 18% solids dispersion. It was noted that for a given amount of this salt, the pH would reach a constant value soon after the addition and before the latex started to clear. Upon further stirring the latex would coagulate, but, regardless of the mixing time, the pH did not change from that obtained initially. Coagulant to bring the final pH to 4.6 was necessary before uniform sheets free of "splinters" were obtained. Data obtained on these sheets are given in Table XI.

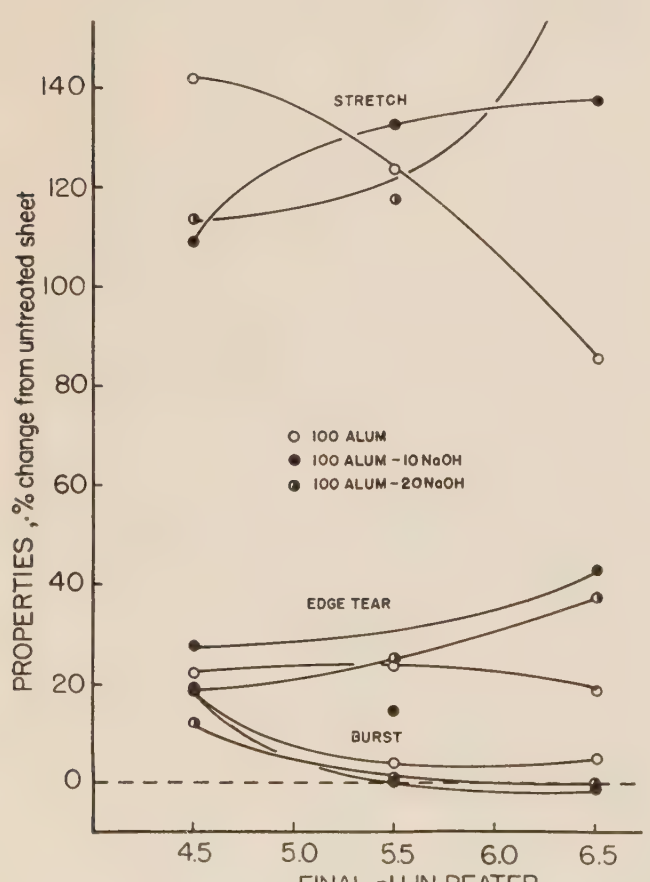

Fig. 8. Effect upon sheet properties of coagulating with alum and alum-sodium hydroxide mixtures to given pH values

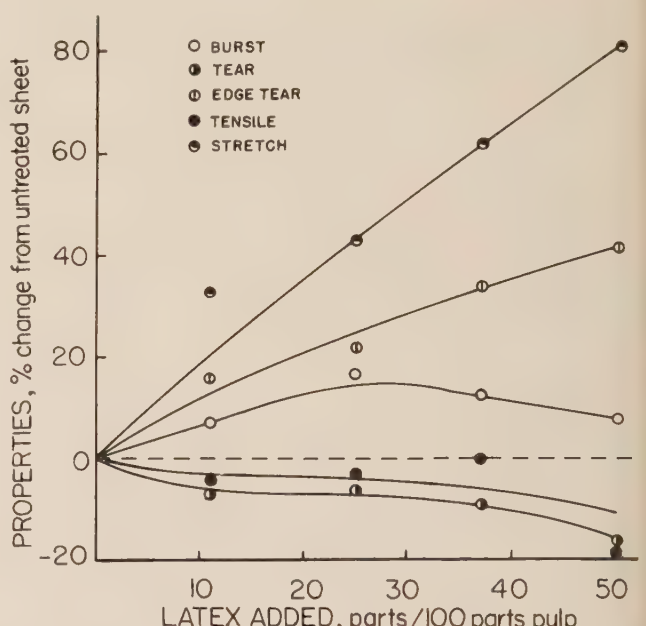

Fig. 9. Effect of amount of rubber added upon sheet properties

The tensile and bursting strengths of these sheets were considerably lower than values obtained from sheets in which alum was used as the coagulating agent. Stretch was not appreciably affected.

In view of further experiments and a successful mill run using alum, it appears that the use of sodium silico fluoride offers no particular advantage in this process.

Effect of Coagulating with Acid and Acid/Alum Mixtures. An attempt was made to coagulate the latex with a 10% solution of sulphuric acid. Addition of sulphuric acid to bring the pH to 4.0 did not coagulate the latex. With another batch, 8.3 parts of sulphuric acid per 100 parts of pulp were added followed by 2.0 parts of alum. This coagulated the latex but the pH was below 4.0 and the sheet was so splintery that it was not tested. Another attempt was made by adding 1.3 parts of sulphuric acid and 4.2 parts of alum per 100 parts of pulp. This also brought the pH to a value below 4.0, but again the sheet was so splintery that it was not tested. Addition of a mixture of 100 parts of alum and 40 parts of sulphuric acid (both at 10% concentration) to bring the pH to 4.5 also gave a splintery sheet.

Table XI. Effect of Coagulating with Sodium Silicon Fluorides

Latex, parts	0	50	50	50	50	50	50
Coagulating agent, type	Alum	Alum	NaSF	NaSF	NaSF	NaSF	NaSF
Coagulating agent, parts	5.0	7.9	1	2	3	4	5
Final pH	4.5	4.5	7.6	5.4	4.6	4.6	4.7
Minutes to clear	...	...	30	30	30	15	10
Sheet appearance	Good	Good	Splintery[a]	Splintery[a]	Fair	Good	Good
Burst factor	88	97	...	57	62	68	77
Tear factor	275	236	...	269	306	257	247
Tensile strength, lb.	24.1	18.7	...	15.5	12.5	14.3	16.6
Stretch, %	2.7	4.5	...	4.6	3.5	4.4	4.4

[a] Sheets not tested.

In view of these experiments it appears that acid or acid/alum mixtures cannot be used effectively in coagulating this latex in pulp.

Effect of the Amount of Latex

To determine the effect of the amount of latex, various amounts of latex were added to the pulp. Attempts to incorporate 67 parts of latex solids to 100 parts of moisture-free pulp gave a sheet with free lumps of rubber after the alum was added. Satisfactory sheets were made when 50 parts of rubber per 100 parts of pulp were used and this was the highest amount of latex used in this study.

Results are shown in Table XII and Fig. 9.

Table XII. Effect of Amount of Latex

Latex, parts					
Pulp/latex ratio	100/0	90/10	80/20	73/27	67/33
Alum, parts	4.6	4.9	5.8	6.8	8.0
Burst factor	84	90	98	95	91
Tear factor	295	274	283	267	248
Edge tear, lb.	6.4	7.4	7.8	8.6	9.0
Tensile strength, lb.	18.4	17.6	17.8	18.4	15.0
Stretch, %	2.1	2.8	3.0	3.4	3.8

Both stretch and edge tear were increased roughly as a straight-line function of the amount of latex added, especially after the initial addition. Bursting strength was increased with moderate addition giving higher bursting strength values than the addition of 50 parts of latex. Tensile strength underwent little change until after 37 parts of latex had been added, in which case it fell off. Tearing strength was progressively decreased with increasing amounts of latex.

Effect of Latex Concentration

To determine the effect of latex concentration, latex at 30.7 and 3.6% solids was added to pulp. In order to eliminate the variable of pulp concentration, pulp beaten at 4.9% consistency was used, and water was added to either the pulp or to the latex so that the consistency after adding the latex was approximately the same in both cases. Test results are given in Table XIII.

Table XIII. Effect of Latex Concentration

Pulp concentration	4.9%	3.0%
Latex concentration	3.6%	30.7%
Water in 100 parts pulp solids	1941	3233
Water in 50 parts latex solids	1990	113
Total water present	3331	3346
Alum parts	6.7	7.0
Burst factor	61	63
Tear factor	344	331
Edge tear, lb.	8.1	8.6
Tensile strength, lb.	10.7	9.5
Stretch, %	4.3	3.9

These results indicate that there is little difference in strength properties brought about by an 8.5-fold dilution of the latex, provided the pulp concentration is not changed. This is fortunate as there are definite handling advantages to using the latex as received.

SUMMARY

A number of nitrile rubber latex variables have been studied to determine their effect on beater impregnation. The work was limited to latices prepared with one basic polymerization system, and to a medium beaten Scandinavian unbleached kraft pulp.

The results of this study indicate that a rubber of medium acrylonitrile content and molecular weight, and with no additional stabilization after polymerization will give optimum properties.

When alum was used as the coagulating agent, optimum properties were obtained at a final pH range of 4.5 to 5.5. Coagulation may be carried out with either dry alum or alum solution. Somewhat better properties were obtained by coagulating with a 100–20 mixture of alum-sodium hydroxide at a final pH of 5.5 to 6.5. Coagulation with acids and acid-alum mixture as well as final pH values much above 6.5 are to be avoided as these conditions cause sticky sheets.

Vulcanization of the latex after coagulation appears to give a beneficial effect, but this is more than offset by the losses in properties brought about by the extra stabilizer that must be added along with the curing ingredients.

Plasticizers for the latex improved drape and softness of the sheet, but at the expense of strength.

Both stretch and edge tear were increased roughly as a straight-line function of the amount of latex added, while tearing strength progressively decreased. Bursting strength increased to a maximum, while tensile tended to decrease.

Dilution of the latex from 30.7 to 3.6% before addition to the pulp did not appreciably change the properties when the pulp concentration remained constant.

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Effect of Certain Papermaking Variables upon Beater Addition of Nitrile Rubber Latices

D. M. YOST and W. H. AIKEN

The effect of a number of papermaking variables upon beater addition of a nitrile rubber latex has been studied. Latex may be added to the pulp either before or after beating, but it should not be coagulated until near the end of the beating process. The amount of latex that could be incorporated in a beaten unbleached kraft pulp was greatly increased by reducing the pulp consistency. For latex contents up to 33 parts per 100 parts of pulp, better properties were obtained at higher pulp consistency. For greater amounts of latex, better properties were obtained at lower pulp consistencies. The amount of latex that could be incorporated into unbleached kraft pulps was increased by beating. Unbeaten bleached kraft pulps showed a greater tolerance for latex than did unbeaten unbleached kraft pulps; however, beating the bleached pulps did not increase their tolerance for latex. Addition of latex increased the elongation and reduced the stiffness of all pulps tested. The effect on other properties depended to a great extent on the type of pulp used. Addition of latex to pulp showed little effect on drainage properties. The stretch and tearing strength of latex-containing sheets relative to sheets without latex remained unchanged with variation in basis weight. Edge tear, bursting strength, and tensile strength, on the other hand, showed relatively higher values at the higher basic weights. Spot checks indicated that pulp to which latex has been added may be dyed. With the two colors tested, best physical properties were obtained when the color was added after the latex but before the alum. Addition of clay to pulp-latex systems reduced physical properties to the extent that its use does not appear advisable. Addition of rosin size appeared to give no difficulties in latex-pulp systems. It appeared that wet broke can easily be reworked without difficulty or appreciable reduction of properties. Dry broke, on the other hand, was hard to redisperse and gave substantially reduced properties. A mill run made with the latex developed in these studies showed excellent correlation with laboratory studies on pulp-latex and further demonstrated the practicability of these mixtures.

FROM a laboratory study of the effect of variables in a butadiene-acrylonitrile latex on properties of paper impregnated with the latex at the beater, it was indicated that a latex of medium acrylonitrile content, medium molecular weight, and minimum stabilizer content gives interesting properties when incorporated into a beaten Scandanavian unbleached kraft pulp and coagulated with alum (*1*).

After the type of latex and method of coagulation were determined, it appeared desirable to study the effect of a number of papermaking variables upon beater addition of the latex. The following variables were studied:

Effect of adding latex before and after beating
Effect of further beating after coagulation of latex
Effect of pulp consistency
Effect of amount of beating
Effect of type of pulp
Effect of latex addition upon freeness
Effect of other beater additives
Effect of basis weight

These studies led to a mill run, followed by a study on the effect of latex on reworking broke.

In all of these studies, Chemigum latex 245B was used. Unless otherwise specified, a Scandanavian unbleached kraft pulp (Korsnas) beaten at 3% consistency for 15 minutes in a Noble and Wood laboratory beater with 80 pounds on the beater arm was used; 50 parts of latex solids were added per 100 parts of moisture-free pulp, followed by the addition of sufficient 10% alum solution to bring the pH to 4.5. The general techniques and testing procedures previously described (*1*) were employed.

EFFECT OF ADDING LATEX BEFORE AND AFTER BEATING

To determine the most logical time in the beating cycle to add and coagulate the latex, the following methods were studied: (1) beat the pulp, add latex, add alum; (2) add latex, beat the pulp, add alum; (3) add latex, add alum, beat the pulp; (4) beat the pulp, add alum, add latex.

The experiments were carried out in the laboratory beater. Test results are given in Table I.

Table I. Effect of Adding Latex Before and After Beating

Addition procedure[a]	B-A	B-L-A	L-B-A	L-A-B[b]	B-A-L[c]
Burst factor	88	86	90	...	...
Tear factor	275	241	242	...	...
Tensile strength, lb.	24.1	16.4	16.5	...	...
Stretch	2.7	4.9	3.8	...	...

[a] B = beat the pulp; L = add latex; A = add alum.
[b] When alum was added, the latex coagulated to give lumps of rubber.
[c] When the latex was added, it coagulated to give lumps of rubber.

Addition of the latex to the pulp after beating followed by coagulation with alum gave the best results. Comparable results were obtained by adding latex, beating, and then coagulating with alum, with the exception that stretch was somewhat lower. Although this latex is not considered to be highly stable to mechanical agitation, there appeared to be no tendency for the latex to coagulate during beating. This indicates that it may be possible to add latex ahead of a jordan and coagulate afterward. Should it be desirable to do this, mechanical stability can be improved by keeping the latex-pulp mixture well on the alkaline side.

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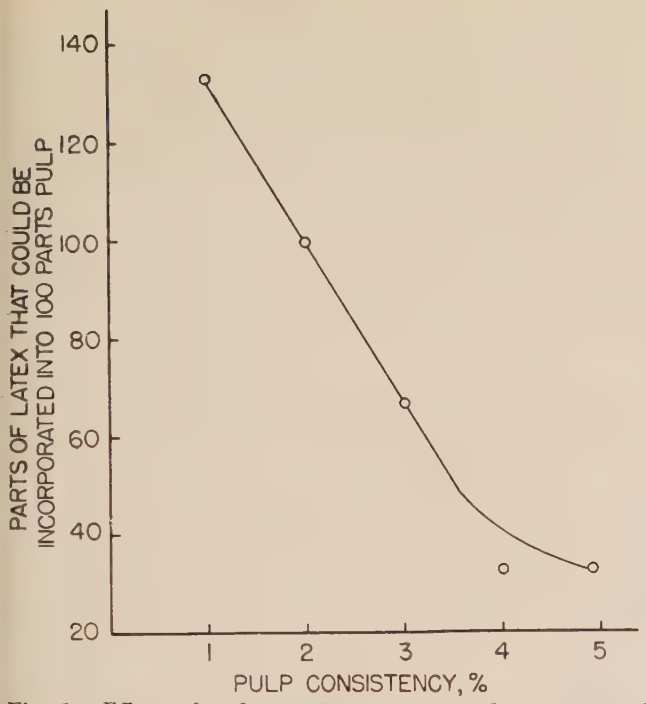


Fig. 1. Effect of pulp consistency upon the amount of latex that could be incorporated into a beaten unbleached kraft pulp

Although 50 parts of latex could be added to unbeaten pulp without difficulty, when alum was added the latex coagulated to give lumps of rubber. In subsequent studies, it was found that for many pulps it was impossible to coagulate substantial amounts of latex in the presence of unbeaten pulp without getting lumps of rubber but that this difficulty disappeared when coagulation was carried out after the pulp was beaten. This is probably related to the greater surface of beaten pulp on which the latex can coagulate.

When alum was added to the beaten pulp, followed by addition of the latex, coagulation of the latex into lumps occurred. Apparently the alum in the water agglomerated the rubber particles before they had the opportunity to come in contact with the fiber surface.

From these experiments it was indicated that latex should be added after beating, followed by the coagulating agent.

EFFECT OF FURTHER BEATING AFTER COAGULATION OF LATEX ONTO FIBERS

In order to obtain closer control in the papermaking process, it is standard practice to complete the treatment of the stock by passing it through one or more jordans. If this is to be done on pulp-latex systems, it is important to know the effect of such treatment.

Scandanavian unbleached kraft pulp was beaten for 15 minutes in the laboratory beater with 80 pounds on the beater arm. Fifty parts of latex per 100 parts of moisture-free pulp were then added, followed by sufficient alum solution to bring the pH to 4.5. After withdrawal of a sample for sheets, the weight on the beater arm was set at 0 and the pulp circulated for 60 minutes. After withdrawal of another sample, the weight was again set at 80 pounds and the pulp beaten an additional 6 minutes. As a control, pulp was given the same beating and circulating procedure, with samples taken at each period for sheets with and without latex. The results are given in Table II.

These results indicate that a moderate amount of beating after coagulation of the latex is permissible and that the action of further beating does not dislodge the rubber from the fibers to an extent sufficiently great to cause sheetmaking difficulties or to appreciably reduce the properties imparted by the latex.

EFFECT OF PULP CONSISTENCY

Another common variable in the papermaking process is stock consistency. Most of the studies of this investigation were carried out on pulp at 3% consistency, as this is the consistency normally used in the laboratory beater. However, in production, pulps are beaten at higher consistencies. To simplify the process it would be desirable to add latex to the pulp at regular beating consistency, unless there is a good reason for doing otherwise.

To determine the effect of pulp consistency, Scandanavian unbleached kraft pulp was beaten at 4.9% consistency for 20 minutes with 80 pounds on the beater arm. Portions of pulp were removed to buckets and various amounts of latex added followed by addition of alum solution to coagulate the latex and bring the pH to 4.5. The pulp remaining in the beater was diluted stepwise to 4, 3, 2, 1, and 0.5% consistency, with portions removed at each concentration for addition of latex. Because of the large volume, only one latex concentration was added to the 0.5% pulp.

Test results are given in Table III.

When alum was added to pulp at 4.9% consistency which contained 50 parts of latex, the latex coagulated as lumps of rubber, but 33 parts of latex could be added without difficulty. As the consistency of the pulp was decreased, the amount of rubber that could be incorporated was increased. At 1% consistency 100 parts of latex could be incorporated without difficulty, and sheets were made using 133 parts of latex, although the sheets had a tendency to be sticky. The effect of pulp consistency upon the amount of latex that could be incorporated into the sheet is shown in Fig. 1.

Table II. Effect of Further Beating After Coagulating Latex on Fibers

System[a]	Pulp-bucket			Pulp-latex-bucket			Pulp-latex-beater		
Beating[b]	B	B-C	B-C-B	B	B-C	B-C-B	B	B-C	B-C-B
Latex, parts	0	0	0	50	50	50	50	50	50
Alum, parts	3.6	3.3	3.6	6.2	6.5	6.5	7.3	7.3	7.3
Burst factor	97	113	134	66	92	97	91	105	118
Tear factor	289	252	245	261	237	218	268	259	266
Edge tear, lb.	6.7	6.0	6.4	8.0	8.0	9.9	8.3	8.3	8.7
Tensile strength, lb.	8.0	23.2	24.8	9.7	14.8	13.7	14.7	16.3	21.7
Stretch, %	2.3	3.0	3.2	3.1	3.8	3.9	3.8	3.5	3.3

[a] Pulp-bucket: Pulp was beaten, then withdrawn to bucket for alum addition. Pulp-latex-bucket: pulp was beaten, then withdrawn for latex and alum addition. Pulp-latex-beater: pulp was beaten 15 minutes, then latex and alum added to the beater, followed by further circulation and beating.
[b] B—beaten 15 minutes. B-C—beaten 15 minutes, then circulated 60 minutes with 0 weight on arm. B-C-B—beaten 15 minutes, then circulated 60 minutes with 0 weight on arm, then beaten 6 minutes.

For the control sheet in which no latex was used, the sheets made at 1% consistency were deficient in all properties, compared to those made from pulps at higher consistencies. This was probably due to the relatively large amount of alum necessary to reduce the pH to 4.5 at 1% consistency. The excessive amount of alum required was due to the extreme hardness of the dilution water.

At 22 parts of latex, decreasing pulp consistency gave slight improvements in bursting and tensile strength but a slight reduction in edge tear and a considerable reduction in tearing strength. Stretch was relatively unchanged.

At 33 parts of latex, bursting strength was slightly improved by reduced consistency, while tensile strength and stretch were not effected. Edge tear and tearing strength were both considerably reduced.

Table III. Effect of Pulp Consistency

Latex: 0 parts					
Pulp consistency, %	1	2	3	4	4.9
Alum, parts	9.0	4.7	3.3	2.8	2.8
Burst factor	40	61	74	69	69
Tear factor	293	355	328	340	387
Edge tear, lb.	5.7	7.5	7.0	7.1	8.0
Tensile strength, lb.	11.7	18.0	12.8	15.3	16.8
Stretch, %	1.7	2.3	2.1	2.0	2.6
Latex: 22 parts					
Pulp consistency, %	1	2	3	4	4.9
Alum, parts	12.0	6.7	6.3	4.8	4.5
Burst factor	75	77	76	78	70
Tear factor	320	315	318	324	371
Edge tear, lb.	8.0	8.0	8.9	9.2	8.6
Tensile strength, lb.	15.7	16.7	13.7	13.2	13.0
Stretch, %	3.5	3.3	3.5	3.7	2.9
Latex: 33 parts					
Pulp consistency, %	1	2	3	4	4.9
Alum, parts	16.7	7.3	5.7	5.5	4.8
Burst factor	80	75	70	71	59
Tear factor	306	308	345	374	367
Edge tear, lb.	8.6	8.8	8.9	10.1	6.5
Tensile strength, lb.	11.2	9.5	13.8	10.7	10.5
Stretch, %	4.2	3.6	4.1	3.8	4.0
Latex: 50 parts					
Pulp consistency, %	0.5	1	2	3	4	4.9
Alum, parts	26.0	19.7	7.7	6.7	...	...
Burst factor	108	89	75	61	...	...
Tear factor	236	271	310	344	...	...
Edge tear, lb.	12.5	9.4	9.8	8.1	...	...
Tensile strength, lb.	16.7	10.7	9.0	10.7	...	...
Stretch, %	5.2	4.9	4.0	4.3	...	...
Latex: 67 parts					
Pulp consistency, %	1	2	3	...	...
Alum, parts	21.7	9.3	7.3	...	...
Burst factor	88	67	56	...	...
Tear factor	260	314	295	...	...
Edge tear, lb.	11.3	9.8	9.5	...	...
Tensile strength, lb.	10.3	8.4	8.3	...	...
Stretch, %	7.3	4.3	5.5	...	...
Latex: 100 parts					
Pulp consistency, %	1	2	...	...	
Alum, parts	23.7	10.7	...	...	
Burst factor	76	53	...	...	
Tear factor	250	297	...	...	
Edge tear, lb.	11.6	8.2	...	...	
Tensile strength, lb.	9.3	7.5	...	...	
Stretch, %	8.7	5.8	...	...	

At 50 parts of latex there was a rather sharp change in trends. Bursting strength and edge tear were definitely improved by reduced pulp consistency and stretch was improved to a lesser degree. Tensile strength remained relatively unchanged from 4.9 to 1% consistency, with a marked improvement indicated at 0.5% consistency. Tearing strength was reduced by reduced pulp consistency.

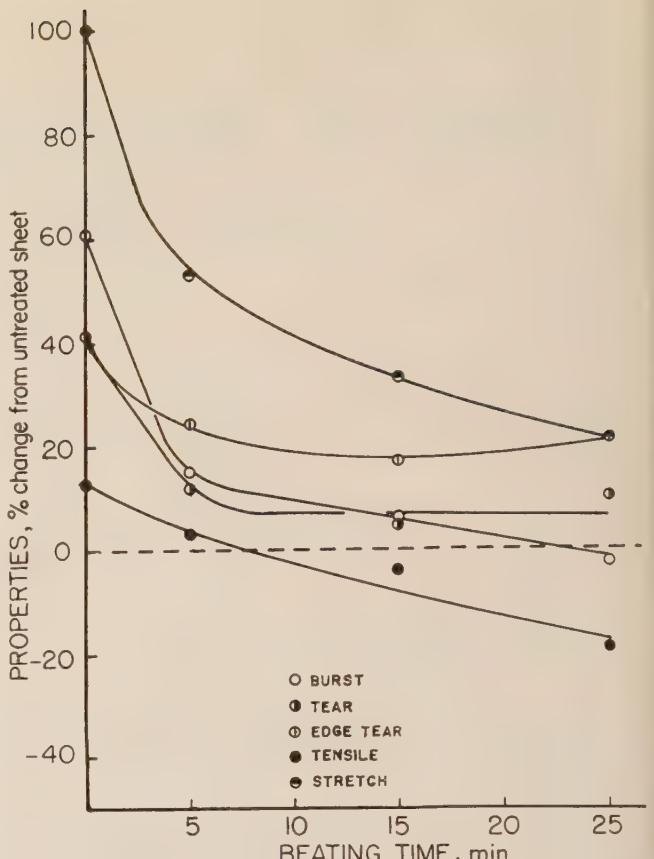


Fig. 2. Properties imparted to an unbleached kraft pulp by the addition of 22 parts of latex solids per 100 parts of moisture-free pulp

At 67 and 100 parts of latex the same general trends were present as exhibited with 50 parts of latex.

In general, it appears that up to 33 parts of latex, it is not worth while to dilute the pulp before addition of the latex. If 50 or more parts of latex are desired, dilution of the pulp to 3% or below is indicated. Not only does dilution increase the ease of incorporation of larger amounts of latex, but greater improvements are realized for a given amount of latex. A balance between the properties to be obtained and the available chest capacity will have to determine the extent to which dilution is carried out.

EFFECT OF AMOUNT OF BEATING

In determining the sequence to use in adding latex to the pulp, it was observed that when 50 parts of latex were added to 100 parts of pulp at 3% consistency, followed by addition of alum, good sheets resulted if the pulp had been beaten 15 minutes but that the latex coagulated in lumps if the pulp was not beaten. In order to determine the effect of the amount of beating on the amount of latex that could be incorporated into a pulp at 3% consistency, a Scandanavian unbleached kraft pulp (Korsnas) was beaten for 0, 5, 15, and 25 minute periods.

Latex was added to the pulp in a gallon bucket and alum solution added to coagulate the rubber and bring the final pH of the water to 4.5 using the method previously described. Initial tests were made on the pulp

at a given beating period using 22 parts of latex solids per 100 parts of fiber. If satisfactory sheets could be made, additional batches were made in steps of 33, 50, 67, and 100 parts of latex solids until satisfactory sheets could no longer be made. This point was considered reached when one or more of the following conditions were observed:

(1) A relatively large number of lumps of rubber were present in the pulp after addition of the alum.
(2) The screen was partially filled with rubber particles when the wet weigh sheet was removed.
(3) The screen was partially filled with rubber particles when the dried sheet was removed.

Test results are given in Table IV and Figs. 2 to 8.

The amount of latex which could be incorporated into the pulp increased with increased beating time.

Table IV. Effect of Amount of Beating and Amount of Latex Added upon Properties of Scandanavian Unbleached Kraft Coniferous Pulp

Beating time: 0 minutes						
Latex, parts	0	22	33[a]			
Alum, parts	3.3	4.2	4.9			
Burst factor	23	37	...			
Tear factor	208	295	...			
Edge tear, lb.	3.3	4.7	...			
Tensile strength, lb.	6.0	6.8	...			
Stretch, %	1.2	2.4	...			
Stiffness, cm.^{3}/100	45.0	22.0	...			
Beating time: 5 minutes						
Latex, parts	0	22	33	50[a]		
Alum, parts	3.3	4.2	4.9	4.9		
Burst factor	54	62	65	...		
Tear factor	320	358	338	...		
Edge tear, lb.	5.4	6.7	7.8	...		
Tensile strength, lb.	12.0	12.3	10.8	...		
Stretch, %	1.9	2.9	4.3	...		
Stiffness, cm.^{3}/100	82.0	61.5	31.9	...		
Beating time: 15 minutes						
Latex, parts	0	22	33	50	67[a]	
Alum, parts	3.8	4.9	5.5	6.1	6.3	
Burst factor	88	93	95	93	...	
Tear factor	295	310	256	250	...	
Edge tear, lb.	7.0	8.2	9.2	9.6	...	
Tensile strength, lb.	18.8	18.0	15.0	13.5	...	
Stretch, %	2.4	3.2	4.3	5.7	...	
Stiffness, cm.^{3}/100	120.0	41.8	33.8	10.9	...	
Beating time: 25 minutes						
Latex, parts	0	22	33	50	67	100[a]
Alum, parts	3.8	4.5	5.3	5.8	6.1	6.8
Burst factor	126	122	120	102	100	...
Tear factor	255	280	233	218	200	...
Edge tear, lb.	6.7	8.3	6.4	8.3	9.8	...
Tensile strength, lb.	26.3	21.3	18.5	15.8	14.3	...
Stretch, %	2.8	3.4	3.8	4.9	5.3	...
Stiffness, cm.^{3}/100	112.0	49.0	27.5	25.6	22.0	...

[a] When alum was added, the latex coagulated to give lumps of rubber.

Figure 2 shows properties of sheets containing 22 parts of latex relative to properties of sheets containing no latex. It is seen that the relative values of all properties are greater at lower beating periods and either fall off or level out with increased beating. The same trend is evident in sheets containing 33 and 50 parts of latex.

Casual examination of these results may lead to the conclusion that optimum properties would be obtained with unbeaten pulps. Although the addition of latex to the unbeaten pulp improves all properties, the amount of latex which can be incorporated in the unbeaten pulp does not bring the strength properties in the range of those possible with beaten pulps. Therefore, a combination of beating and latex addition is necessary to obtain optimum properties with this pulp.

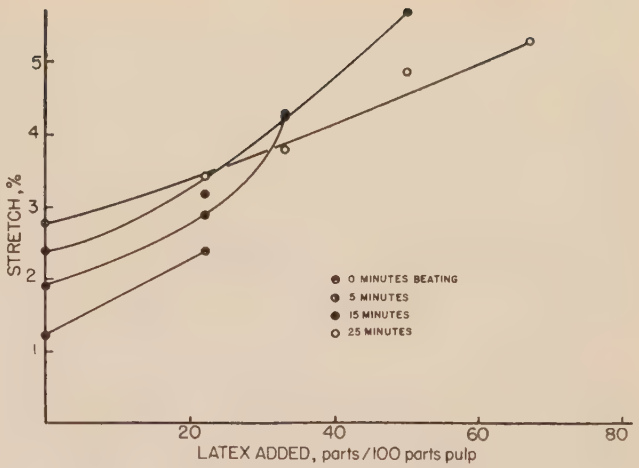


Fig. 3. Effect of latex addition upon the stretch of an unbleached kraft pulp

Figures 3 to 8 show the effect of the amount of beating and latex added upon properties. From these results, the following trends are indicated with increasing latex content.

Stretch. Large improvements were obtained up to a maximum increase of 100%.

Edge Tear. Improvements were realized up to a range of 40%.

Stiffness. There was a reduction at all concentrations with the slope greater at the 15 and 25-minute beating periods than at the 0 and 5-minute beating periods. However, the 25-minute beating curve flattened off at 33 parts of latex, so that minimum stiffness was produced at the 15-minute beating period.

Bursting Strength. Substantial improvements (60% increase) in burst were realized at the 0 beating time but the improvement was reduced with increased beating to the extent of 5% improvement at the 15-minute beating period. At the 25-minute beating period, bursting strength was reduced by the addition of latex, especially after the addition of as much as 33 parts.

Tearing Strength. At 0 beating time an improvement in the range of 40% was realized. This was reduced with increased beating so that at 15 and 25-minute beating periods, tearing strength was progressively reduced by addition of latex to a maximum loss in the order of 20%.

Tensile Strength. A very slight improvement was realized at 0 beating time. At higher beating times, tensile strength was reduced with progressive addition of latex, the reduction being greater as beating progressed. Maximum reduction at the 25-minute beating time was in the order of 45%.

Optimum Properties. Examination of Figs. 3 to 8 shows that in order to add sufficient latex to this pulp to get high values of edge tear, stretch, and flexibility, more than 5-minute beating time was necessary. It is also evident that higher values of these properties were obtained for a given large addition of latex at the 15-minute beating period than at the 25-minute beating period. Since the addition of latex reduced the spread of tensile and bursting strength values between the 15 and 25-minute periods, there was not a great deal of sacrifice in these properties by picking the 15-minute beating period. One therefore concludes that in this

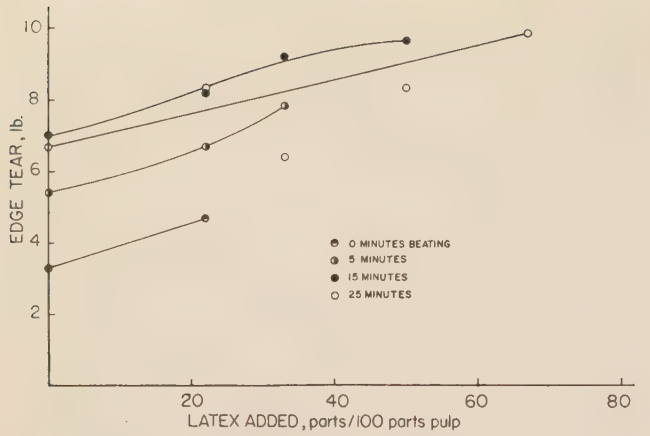


Fig. 4. Effect of latex addition upon the edge tear of an unbleached kraft pulp

pulp, a beating time of 15 minutes was optimum. The amount of latex to use will depend on the particular properties desired but the use of 33 to 50 parts per 100 parts of pulp was indicated.

EFFECT OF TYPE OF PULP

To determine the effect of the type of pulp upon properties obtained with beater impregnation of latex, studies similar to those reported above for Korsnas were made on 15 pulps and pulp mixtures.

The amount of latex which could be incorporated into the pulps at different beating periods are given in Table V.

Table VI gives properties of sheets prepared at one beating period and one latex concentration for each pulp. The beating period and latex concentration shown were selected in each case to give high values of stretch and edge tear and low values of stiffness.

Table V. Effect of Amount of Beating on Amount of Latex that Could Be Added

Beating time, minutes	*Latex concentration[a] at which poor sheets resulted*			
	0	5	15	25
Type pulp and trade name				
Scandanavian unbleached kraft (Korsnas)	33	50	67	100
Canadian unbleached kraft (Dryden)	33	67	67	67
West coast unbleached kraft (Bloedel)	22	50	50	100
Southern unbleached kraft (Chesapeake)	33	50	100	100
50 Scandanavian unbleached kraft (Korsnas) / 50 Hardwood unbleached kraft (Brown)	50	100	79[b]	79[b]
Northern bleached kraft (Frazier)[c]	67	67	50	67
Northern bleached high alpha kraft (Cellate)[c]	67	67	67	50
Northern alpha (Brown no. 1 alpha)	33	50	50	50
West Coast sulphite alpha (Soundview)	50	67	50	22
Northern unbleached Mitscherlich sulphite	33	50	100	...
Scandanavian unbleached sulphite (Ahlstrom)	33	50	33	33
West Coast bleached sulphite (Soundview)	50	50	50	67
Rope	100	67	...	...
Groundwood	100	...	...	...
50 Groundwood	...	...	...	...
50 West Coast bleached sulphite (Soundview)	...	...	50	...

[a] Parts of solids per 100 parts of moisture-free fiber.
[b] In this case latex was added in increments of 26, 39, 59, and 79 parts per 100 parts of pulp.
[c] On the bleached kraft pulps, 100 parts of latex could be incorporated into the unbeaten pulp at all beating periods without plugging the screens. However, in all sheets containing 67 and 100 parts of rubber, there were many translucent spots in the dried sheets, indicating the presence of free rubber. Therefore, although sheets were made with these higher concentrations, they were not indicated in Table V as being satisfactory.

From the data on the various pulps, the following conclusions may be drawn.

Unbleached Kraft Pulps

The amount of latex which could be incorporated into unbleached kraft pulps increased with increased beating. Addition of latex gave a smaller percentage property improvement to beaten pulps than to unbeaten pulps.

Substantial improvements in stretch, edge tear, and drape (loss of stiffness) were imparted to unbleached pulps by the addition of latex. These changes were accompanied by appreciable loss in tensile strength and minor loss in tearing strength. Small improvements in bursting strength were indicated at low latex concentrations. Of the unbleached kraft pulps tested, greatest improvements were obtained with the Scandanavian pulp, and next best with the southern pulp. The West Coast and Canadian pulps and the mixture of hardwood and Scandanavian pulps showed somewhat smaller improvements upon the addition of latex.

Bleached Kraft Pulps

The amount of latex that could be incorporated into bleached kraft pulp appears to be independent of beating. As in the case of the unbleached pulps, largest percentage improvements were given by addition to unbeaten pulp.

Loss of stiffness and an improvement in stretch were imparted to bleached kraft pulps by the addition of latex, accompanied by a loss in tensile and bursting strength. There was a slight loss in tearing strength but little change in edge tear.

Alpha Pulps

The amount of latex that could be incorporated in the northern alpha was not greatly dependent upon the amount of beating, however, more latex could be incorporated in the beaten pulps than in the unbeaten pulp. Contrary to results on most other pulps, the West Coast alpha showed less tolerance for latex at higher beating periods. With both pulps, latex gave the greatest percentage improvement in properties at the lower beating periods.

Addition of latex to both alpha pulps gave substantial reduction in stiffness and substantial improvements in

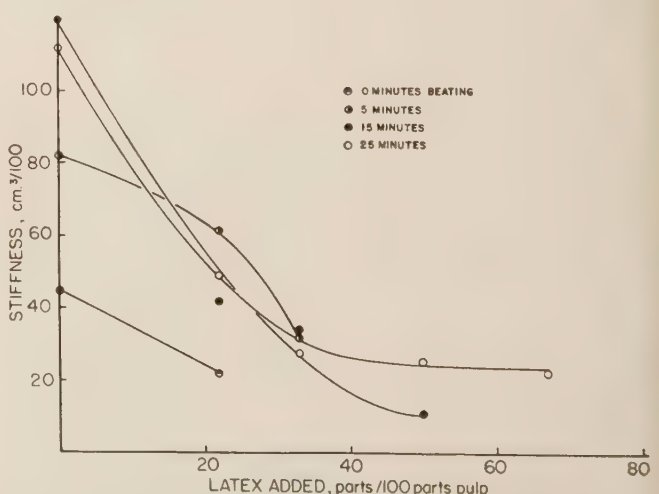


Fig. 5. Effect of latex addition upon the stiffness of an unbleached kraft pulp

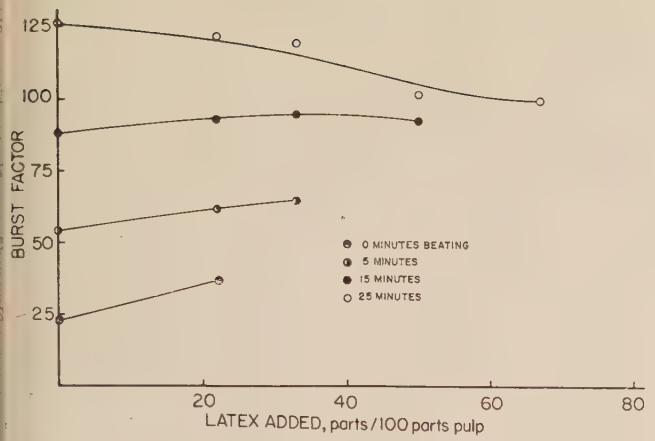


Fig. 6. Effect of latex addition upon the bursting strength of an unbleached kraft pulp

stretch. Bursting strength was little changed, but there was some sacrifice of tensile strength. There was a slight reduction in tearing strength and a slight improvement in edge tear.

Unbleached Sulphite

The amount of latex which could be incorporated into northern unbleached Mitscherlich sulphite pulp was increased with increased beating. The percentage improvement imparted by latex addition was greater at the lower beating periods. Addition of latex to this pulp reduced stiffness appreciably and gave substantial improvements in stretch. Tearing strength was only slightly changed, but edge tear, tensile and bursting strengths were reduced, especially at the higher latex concentrations.

The amount of latex which could be incorporated into the Scandanavian unbleached sulphite pulp was not appreciably changed by beating. However, pitch trouble may have been responsible for part of the trouble encountered in trying to incorporate large amounts. Incorporation of latex into this pulp gave substantial reductions in stiffness and improvements in stretch. Bursting strength and edge tear were little changed. There were slight reductions in tearing strength and greater reductions in tensile strength.

Bleached Sulphite

In the one bleached sulphite treated, the amount of latex that could be incorporated was increased with increased beating. The percentage improvement imparted by addition of latex was greater at the lower beating periods.

Addition of latex reduced stiffness and increased stretch. Edge tear was little changed, and there was only a slight reduction in tearing strength. Tensile and bursting strengths were appreciably reduced, especially at the higher latex concentrations.

Groundwood

Both groundwood and groundwood-sulphite sheets were given large improvements by the incorporation of latex, with the exception that tearing strength and bursting strength were little changed while tensile strength was reduced in both cases.

Rope

Edge tear and elongation were both increased and stiffness reduced by adding latex to rope pulp. At lower latex concentrations, bursting and tearing strengths were improved. There was appreciable loss in tensile strength.

Flooring Saturating Felt

Addition of latex to saturating felt improved elongation, tensile, tearing, and bursting strengths. Large improvements were given by 11 parts, with more latex giving only small additional improvements.

The data from which the above conclusions were

Table VI. Typical Results Possible by Incorporating Latex in Various Pulps

Type pulp and trade name	*Beating time, min.*	*Latex, parts*	*Stretch, %*	*Edge tear, lb.*	*Stiffness, cm.³/100*	*Burst factor*	*Tear factor*	*Tensile strength, lb.*
Scandanavian unbleached kraft (Korsnas)	15	50	5.7 (+137)	9.6 (+37)	10.9 (−91)	93 (+6)	250 (−15)	13.5 (−28)
Canadian unbleached kraft (Dryden)	15	50	3.2 (+33)	7.8 (+20)	28.0 (−71)	93 (−11)	229 (−12)	16.3 (−22)
West Coast unbleached kraft (Bloedel)	25	67	4.4 (+91)	8.6 (+30)	12.0 (−81)	76 (−18)	248 (−22)	9.6 (−56)
Southern unbleached kraft (Chesapeake)	25	67	4.2 (+83)	9.0 (+83)	14.5 (−72)	76 (−28)	198 (−18)	11.6 (−45)
50 Scandanavian unbleached kraft (Korsnas) / 50 Hardwood unbleached kraft (Brown)	25	59	4.4 (+69)	8.0 (+33)	13.6 (−85)	85 (−33)	163 (−28)	11.8 (−57)
Northern bleached kraft (Frazier)	0	33	3.7 (+37)	6.8 (+1)	29.3 (−59)	186 (−7)	223 (−17)	15.3 (−21)
Northern bleached high alpha kraft (Cellate)	0	33	5.1 (+82)	6.5 (+2)	11.9 (−80)	69 (+30)	299 (−13)	11.2 (−7)
Northern alpha (Brown No. 1)	15	33	4.7 (+38)	5.0 (+14)	27.4 (−38)	77 (+3)	120 (−24)	12.5 (−15)
West Coast sulphite alpha (Soundview)	15	22	3.1 (+29)	4.2 (−5)	32.3 (−48)	75 (+3)	140 (−14)	13.0 (−15)
Northern unbleached Mitscherlich sulphite	5	33	3.3 (+48)	3.3 (+18)	26.3 (−42)	86 (−1)	80 (−17)	19.2 (−7)
Scandanavian unbleached sulphite (Ahlstrom)	15	22	3.1 (+24)	4.0 (+5)	26.9 (−51)	104 (−4)	105 (−32)	19.0 (−28)
West Coast bleached sulphite (Soundview)	15	33	3.7 (+48)	5.1 (−4)	25.6 (−51)	70 (−12)	133 (−23)	16.0 (−10)
Rope	5	50	3.7 (+42)	20.3 (+84)	34.0 (−37)	113 (+3)	439 (+1)	11.5 (−38)
Groundwood	0	50	3.5 (+218)	1.8 (+80)	12.3 (−76)	25 (+25)	45 (+28)	5.4 (−4)
50 Groundwood / 50 West Coast bleached sulphite (Soundview)	15	33	3.1 (+63)	4.4 (+33)	14.8 (−73)	50 (−2)	79 (−30)	8.8 (−34)
Flooring saturating felt[a]	0	11	5.0 (+127)	...	...	35 (+119)	155 (+46)	57.5 (+52)

Note: Values in parentheses are percentage change from pulp at that beating period without latex.
[a] These values obtained on 400-pound sheets: 40-pound sheets used on all other pulps.

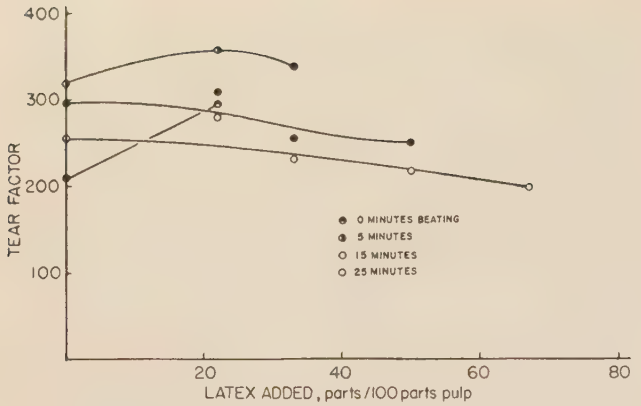


Fig. 7. Effect of latex addition upon the tearing strength of an unbleached kraft pulp

drawn were too voluminous to include in this paper, but are available upon request.

EFFECT OF LATEX ADDITION UPON FREENESS

The data on the effect of the amount of beating and type of pulp upon latex addition make it possible to select a furnish to give the properties desired. However, before a mill run was made, it was necessary to determine the effect of latex addition upon freeness.

The drainage properties of a sheet exert an important influence on its rate of production and thereby upon the cost of producing the sheet. To determine the effect of latex addition upon drainage properties, Sorg freeness measurements were made on a pulp containing various amounts of latex at various beating times. For these studies, a Scandanavian unbleached kraft pulp (Korsnas) with beating periods of 0, 5, 15, and 25 minutes and latex solids addition in steps of 22, 33, 50, and 67 parts per 100 parts of moisture-free pulp were made. Coagulation was carried out in the normal manner in a bucket. Sufficient pulp or pulp-latex mixture was used to give a test sample of 3.75 grams solids.

The Sorg freeness tester is a simple device that measures the amount of water draining in 30 seconds through a 40 by 65 mesh fourdrinier wire 2 inches in diameter, from 3.75 grams of pulp suspended in 575 ml. of water.

The results are given in Table VII and Fig. 9.

Table VII. Effect of Latex Addition on Drainage Time of a Scandanavian Unbleached Kraft Pulp

Beating time, minutes	*Latex added, parts*	*Sorg freeness, ml.*
0	0	495
0	22	465
5	0	460
5	22	430
5	33	430
15	0	405
15	22	385
15	33	400
15	50	410
25	0	355
25	22	365
25	33	380
25	50	375
25	67	435

With exception of the 25 minute beating period containing 67 parts of latex, all values are within + or −7%. Therefore, it may be assumed that the addition of latex would have no appreciable effect upon the drainage rate on a paper machine.

EFFECT OF OTHER BEATER ADDITIVES

Effect of Dye Addition

It may be desirable to produce latex impregnated sheets in a variety of colors. To determine the effect of latex upon dyeing properties and the effect of dye upon strength properties of sheets containing latex, dye was incorporated into both bleached and unbleached pulps. Paris Black was added to Scandanavian unbleached kraft pulp (Korsnas) and Sap Brown was added to northern bleached kraft pulp (Cellate).

Addition of carbon black to unbleached kraft pulp, of course, greatly reduced the strength properties. When carbon black was added to pulp-latex systems, there were losses in properties, but these losses were small compared to the loss in pulp containing no latex. Best physical properties were obtained when the dye was added after the latex but before the alum.

Five parts of carbon black, based on the fiber, was added and uniform coloring was obtained in all cases, the most intense color obtained by adding the black before either the latex or alum.

Addition of 5 parts of Sap Brown, based on the fiber, to bleached kraft pulp improved tensile strength and stretch but slightly reduced edge tear. Addition of the dye to pulp-latex systems gave improvements in all properties tested except for a small reduction in tearing strength. As in the case of the addition of black, best over-all physical properties were obtained when the dye was added after addition of the latex but before the addition of the alum.

Also, as in the previous case, greater color intensity was obtained by adding the dye before addition of latex and alum. However, in the case of the Sap Brown some mottling was observed.

Effect of Adding Clay

If a low-cost filler could be added to a pulp-latex mixture without appreciably changing the properties, part of the cost of the latex could be offset. To determine the effect of filler, various amounts of clay were added to a pulp-latex system. It was found that the incorporation of filler neutralized the beneficial effects of the latex to the extent that its use was not economical. In other words, to develop a given set of physical properties, additional latex was required to an extent that offset the savings in costs brought about by the addition of filler.

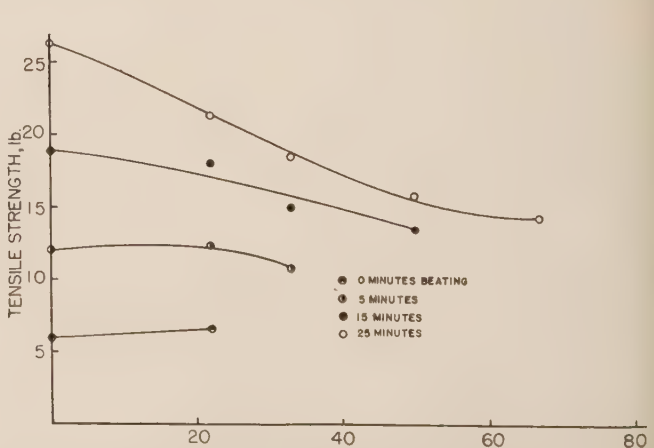


Fig. 8. Effect of latex addition upon the tensile strength of a unbleached kraft pulp

Effect of Adding Rosin Size

Preliminary tests were made in which 2 parts of rosin size, (on the weight of the fiber) were added to a pulp-latex system before coagulation of the latex. No difficulties were indicated upon addition of the size or upon coagulation with alum. However, sufficient data have not been accummulated to determine the combined effect of rosin size and latex upon the properties of the sheet.

EFFECT OF BASIS WEIGHT

It was realized that many applications for latex-impregnated paper would require sheets of heavier weight. In most of the studies in this investigation, sheets of 40 pounds basis weight were used because of convenience in sheet preparation and testing.

To determine the effect of basis weight on the properties of pulp-latex sheets, a batch of Scandinavian unbleached kraft pulp (Korsnas) was treated with latex in the laboratory beater. Sheets of varying weight were prepared with this one batch of material. As a control, sheets of the same weights were prepared from pulp containing no latex.

Test results are given in Table VIII and Fig. 10.

Table VIII. Effect of Basis Weight

A. Control (100 pulp, 4.0 alum)					
Basis weight, lb./ream	40	80	120	200	280
Burst factor	97	114	119	106	101
Tear factor	270	336	213	378	398
Edge tear, lb.	7.0	17.0	27.5	55.2	106.3
Tensile strength, lb.	21.5	40.7	62.0	83.3	94.3
Stretch, %	2.7	3.7	4.3	4.9	4.1
B. 100 pulp, 50 latex, 9.5 alum					
Basis weight, lb./ream	40	80	120	200	280
Burst factor	82	98	109	127	118
Tear factor	299	311	272	339	408
Edge tear, lb.	7.5	18.8	40.8	84.7	125.3
Tensile strength, lb.	13.0	27.8	48.5	85.0	103.7
Stretch, %	3.8	4.9	5.9	7.4	6.3

The stretch and tearing strength of latex-containing sheets remained practically unchanged relative to the control sheets with changes in basis weight. Edge tear, bursting, and tensile strengths, on the other hand, showed relatively higher values at the higher basis weights.

These results indicate that in heavier weight sheets the addition of latex may be even more beneficial than is indicated by data on the lightweight sheets.

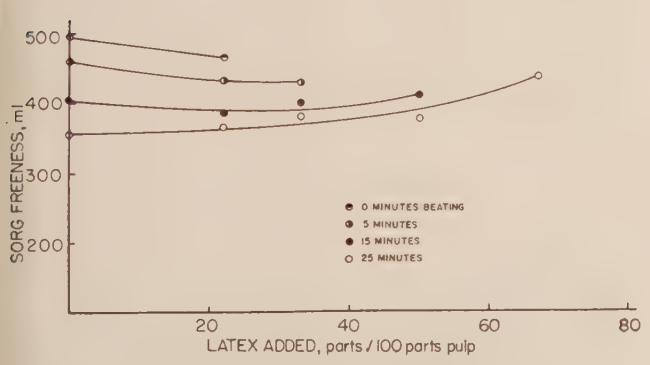


Fig. 9. Effect of latex addition upon the freeness of an unbleached kraft pulp

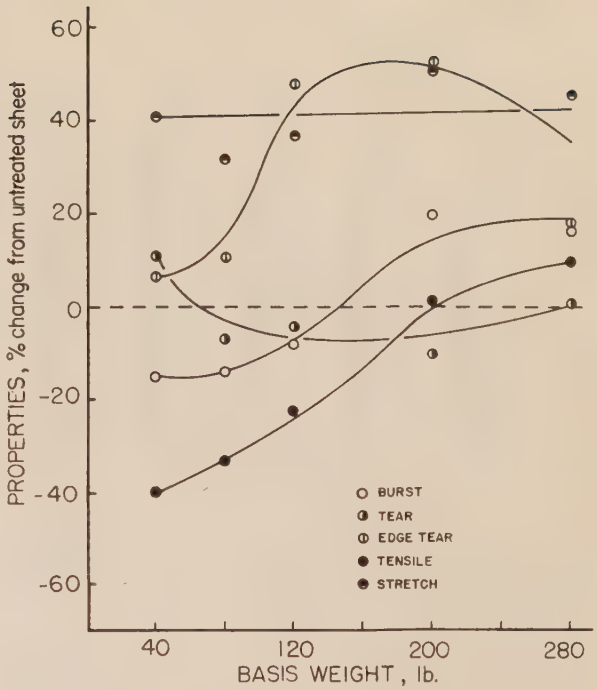


Fig. 10. Effect of basis weight upon the properties of a beaten kraft pulp containing 50 parts of latex solids per 100 parts of moisture-free pulp

MILL RUN

These studies of latex and papermaking variables indicated that latex could be incorporated in the beater using normal papermaking procedures and that no difficulties would be encountered.

To further determine the practicability of this system a mill run was made on a five-cylinder machine. Conditions as closely as possible to those indicated in the laboratory work were used.

Two refiners were each furnished with 3300 pounds (air-dry) of Scandinavian unbleached kraft (Korsnas) that had been broken up in a hydropulper. The pulp was circulated for 90 minutes through a No. 4 hydrofiner set at 280 hp. Beating consistency was 6%. The circulation cycle was about 15 minutes so that the pulp was given an average of six passes through the hydrofiner. The hydrofiner was then backed off, and the stock diluted to 3.5% consistency. Eleven drums of latex were dumped into the chest on the inlet side of the hydrofiner. This latex was 31.1% solids which gave approximately 1650 pounds of solids, or 55.6 parts of latex solids per 100 parts of moisture-free

Table IX. Properties of Machinemade Paper in Which Latex Was Added in the Beater

Thickness, points	19.3		26.5	
Pulp, parts	100		100	
Latex added, parts	55.6		55.6	
Latex in sheets, parts[a]	51.3		51.5	
Latex retention, %	92.2		92.6	
Alum, parts	10.1		10.1	
Basis weight (24 × 36–500)	261		332	
Burst factor	113		[b]	
Sizing (Currier)	608		1411	
	MD	CD	MD	CD
Tear factor	231	309	278	368
Edge tear, lb.	96	93	132	118
Tensile strength, lb.	166	53	212	68
Wet tensile, lb.	55	18	89	24
Wet tensile, % of dry	33	34	42	35
Stretch, %	5.7	20.1	5.5	17.0

[a] From nitrogen analysis.
[b] Bursting strength exceeded 300 p.s.i. capacity of machine.

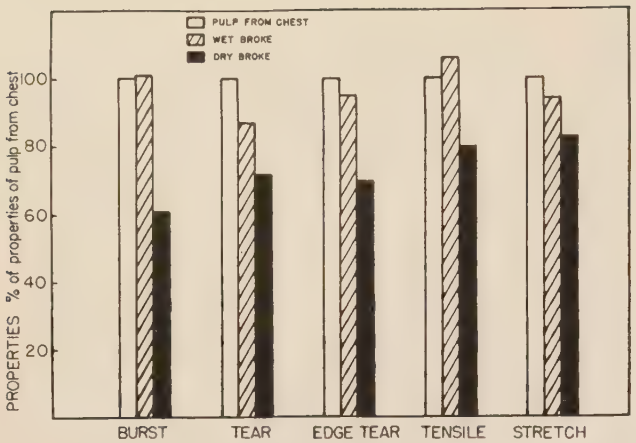


Fig. 11. Effect of reworking broke upon the properties of a pulp-latex mixture prepared in production equipment

pulp. The latex used was Chemigum latex 245B, which was developed from the results of previous laboratory studies (*1*).

Fifteen minutes after the latex was dumped into the chest, 300 pounds of dry alum were added as a 10% solution. This gave 10.1 parts of alum per 100 parts of pulp. Fifteen minutes after the alum was added, the pulp was dumped to the machine chest. The pH in the machine chest of the first batch was 4.4 and of the second batch was 4.7. From the machine chest, the stock was given a light pass through a jordan and went on the machine at approximately 1% consistency.

The stock handled well on the cylinder molds, and for the duration of the run, there was no indication of clogging of wires or picking on the felts. Both 19 and 26-point sheets were made. The properties of these sheets are given in Table IX.

Surprisingly good correlation was obtained in pulp-latex behavior between 100-gram laboratory batches prepared in a gallon bucket, and 4600-pound batches prepared in production equipment. From this it would appear that variations in plant equipment would have little or no effect upon the beater addition of the latex used.

EFFECT OF REWORKING BROKE

The economies of using latex in the beater will be somewhat dependent upon the extent to which the wet and dry broke from the machine can be utilized. To determine the possibility of reworking broke, wet and dry broke from the machine run were compared with pulp taken out of the chest during the run.

The wet broke could be broken up quite easily in the laboratory beater; however, complete defiberization of the dry broke was difficult.

Test results are given in Table X and Fig. 11.

Table X. Effect of Reworking Broke

Type pulp	*From chest*	*Wet broke*	*Dry broke*
Burst factor	92	93	56
Tear factor	245	214	177
Edge tear, lb.	8.2	7.8	5.5
Tensile strength, lb.	15.7	16.7	12.5
Stretch, %	3.6	3.4	3.0

Although slightly deficient in tearing strength, edge tear, and elongation to the pulp from the chest, wet broke gave properties in the same general range. These results, together with the ease of redispersing the wet broke, indicate that it can be reused without difficulty or appreciable reduction of properties.

The dry broke, on the other hand, is hard to disperse and has substantially reduced properties. It is of doubtful value for reworking in the beater.

SUMMARY

The effect of a number of paper making variables upon beater addition of a nitrile rubber latex has been studied.

Latex may be added to the pulp either before or after beating, but it should not be coagulated until near the end of the beating process.

The amount of latex that could be incorporated in a beaten unbleached kraft pulp was greatly increased by reducing the pulp consistency. For latex contents up to 33 parts per 100 parts of pulp, better properties were obtained at higher pulp consistency. For greater amounts of latex, better properties were obtained at lower pulp consistencies.

The amount of latex that could be incorporated into unbleached kraft pulps was increased by beating. Unbeaten bleached kraft pulps showed a greater tolerance for latex than did unbeaten unbleached kraft pulps, however, beating the bleached pulps did not increase their tolerance for latex.

Addition of latex increased the elongation and reduced the stiffness of all pulps tested. The effect on other properties depended to a great extent on the type of pulp used.

Addition of latex to pulp showed little effect on drainage properties.

The stretch and tearing strength of latex-containing sheets relative to sheets without latex remained unchanged with variation in basis weight. Edge tear, bursting strength, and tensile strength, on the other hand, showed relatively higher values at the higher basic weights.

Spot checks indicated that pulp to which latex has been added may be dyed. With the two colors tested, best physical properties were obtained when the color was added after the latex but before the alum.

Addition of clay to pulp-latex systems reduced physical properties to the extent that its use does not appear advisable.

Addition of rosin size appeared to give no difficulties in latex-pulp systems.

It appeared that wet broke can easily be reworked without difficulty or appreciable reduction of properties. Dry broke, on the other hand, was hard to redisperse and gave substantially reduced properties.

A mill run made with the latex developed in these studies showed excellent correlation with laboratory studies on pulp-latex and further demonstrated the practicability of these mixtures.

LITERATURE CITED

1. Yost, D. M., and Aiken, W. H., *Tappi* 34, no. 1:30–39 (Jan., 1951).

Received Nov. 9, 1950. Presented at the Paper-Plastics Conference sponsored by the Technical Association of the Pulp and Paper Industry, Syracuse, N. Y., Oct. 19–20, 1950.

The authors wish to acknowledge the valuable assistance of the many persons in the Sorg Paper Co. and the Goodyear Tire and Rubber Co. who aided in these studies. Special credit is given to Ethel Campbell of Sorg for her help in preparing and testing the handsheets, to D. J. Goodman of Sorg for his assistance in planning the experiments, and to M. E. Wendt of Goodyear for his assistance in planning the experiments and in having the latex prepared.

ASSOCIATION NEWS AND EVENTS

Publication Policies

The Publication Management Committee of the Technical Association of the Pulp and Paper Industry has prepared the following statement of policy relative to the disposition of papers presented at the meetings of the Association.

(a) The Association reserves the exclusive right to determine the disposition of papers presented at its National meetings. Papers of a technical nature will be submitted to the Editorial Board for approval. The Editorial Board considers that an acceptable paper should:

1. Present the results of original work on a subject of interest to the pulp and paper industry.
2. Describe a process or equipment that is novel in its concept or application. Sufficient data should be given to illustrate the results that may be expected from its use. An advertising type of paper will not be acceptable.
3. Present a critical review of a field of pulp and paper, accompanied by pertinent references. A listing of references, without a critical discussion, will not be accepted.

Speeches and addresses of an inspirational, social, or economic nature, as well as purely descriptive papers having immediate news value may be published in *Tappi* or, at the discretion of the Secretary and with the Author's permission, may be released for publication elsewhere.

(b) The disposition of papers presented at meetings of local sections are left to the discretion of the local section executive committees. Any papers deemed to be suitable for publication in *Tappi* may be submitted to the National Secretary for consideration by the Editorial Board.

(c) The Association reserves the right to refrain from publishing in *Tappi* or to refuse for presentation at any of its national meetings, any paper that has previously been released by its author for publication in another magazine.

(d) Authors' condensations of national meeting papers will be available, upon request, for publication by all other magazines as soon as received by the Secretary.

(e) Magazines other than *Tappi* may publish their own condensations, not exceeding 300 words, of papers presented at national meetings. These must be published as part of the text of a running story rather than as separate items. For this purpose, the papers will be made available at the Secretary's office as soon as they are received.

(f) Any paper that has been published in *Tappi* may be copied by other magazines, upon written request to the Secretary provided proper credit is given to *Tappi*. (*Tappi* is copyrighted.)

(g) Under special circumstances technical papers may be released for publication to other magazines before publication in *Tappi*. Such circumstances might occur when it appears desirable to have simultaneous publication of papers on certain subjects or when it is obvious that a paper would serve its purpose better by being published in a magazine serving a field other than the pulp and paper industry. Requests for such papers should be addressed to the Secretary. (Proper credit must be given to *Tappi*.)

Inter-Society Color Council

The annual meeting of the Inter-Society Color Council, of which TAPPI is a member will be held at the Wardman Park Hotel, Washington, D. C., on Feb. 28, 1951. Following the business meeting, at which all member societies will report there will be a symposium on "Color in Government." This will include "Color Standards for Paint," "Color Problems of the Armed Services," and "Miscellaneous Color Studies, Including Textiles, Fading, and the Color Standards Issued by the National Bureau of Standards."

Ohio Section Meeting at Cincinnati

The Ohio Section will meet at the Hotel Sheraton Arms in Cincinnati, Ohio at 6:30 p.m. on Feb. 8, 1951. This meeting which will be held jointly with the Cincinnati Club of Printing House Craftsmen will feature "Quality Control."

Bleaching of Sulphate Pulp

In 1941 the Technical Association issued a monograph-style of booklet on the "Bleaching of Sulphate Pulp," by F. Loeschbrandt, translated by E. Martin. Copies sent to Dr. Loeschbrandt via Sweden, during the war were lost in transit. Recently Dr. Loeschbrandt reported that he had not received any copies. Since these monographs are out of print, Dr. Loeschbrandt would like to receive a few copies from any member of TAPPI who may be willing to send a copy to him.

University Luncheons and Dinners

The TAPPI Alumni groups will hold luncheon on Wednesday, Feb. 21, 1951, as follows:

University of Maine: 12:30 at the Biltmore Hotel.
New York State College of Forestry: 12:00 at the Hendrik Hudson Room, Roosevelt Hotel.
Massachusetts Institute of Technology: 12:30 at the Engineers Club.

The Institute of Paper Chemistry will hold a dinner at the Lexington Hotel on Monday evening, February 19 at 6:30 p.m.

British Testing Standards

The Technical Section of the British Paper and Board Makers' Association has published the following testing methods in 1949 and 1950:

PT 18:pm 1949. Sampling and Testing Paper for Moisture Content.
PT 19:pm 1949. Determination of the Permeability to Water Vapor of Sheet Materials.
PT 5:sm 1950. The Folding Test.

Machinery for Paper Coating

The eighth of the TAPPI Monographs, Machinery for Paper Coating, is being mailed this month to members of the Technical Association. This publication was prepared by the Coating Committee, being one of the series that were initiated under the committee chairmanship of Werner Kaufmann. The subcommittee chairman directly responsible was Frank W. Egan who was ably assisted by Hector Audino, consultant; H. G. Davis, Oxford Paper Co.; and E. E. Thomas, Appleton Machine Co. Because of the rapid developments in the field of paper coating no attempt was made to cover any particular item of equipment specifically. However, it will be found to be an able treatise on the fundamentals of coating equipment, calenders, supercalenders, drying, and auxiliary equipment common to the coated paper industry. Also listed are the more important United States patents covering coating equipment.

PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Walter A. Aldefer, Construction Superintendent, Fleming & Sons, Inc., Dallas, Texas.

William V. Arnold, Jr., Group Supervisor, Marathon Corp., Rothschild, Wis., a 1942 graduate of the University of Wisconsin.

Walter E. A. Axhausen, Engineer, Maschinen-fabrik J. M. Voith, Heidenhelm (Brenz), Germany, a 1937 graduate of Technical University, Berlin.

Charles J. Brown, Sales Engineer, The International Nickel Co., Inc., New York 5, N. Y., a 1949 graduate of the University of Virginia.

Robert C. Brown, Chemical Engineer, Oxford Paper Co., Rumford, Me., a 1946 graduate of Worcester Polytechnic Institute.

Robley A. Butler, Technical Supervisor, Pacific Mills Ltd., Ocean Falls, B. C., Canada, a 1939 graduate of Oregon State College.

Wendell T. Butler, Development Engineer, Setter Bros., Inc., Cattaraugus, N. Y., a 1942 graduate of the University of Maine.

Angelo Cantoni, Mill Manager, Papelera Rio Parana S. A., Buenos Aires, Argentina, a 1936 graduate of Universita di Pavia, with a Ph.D. degree.

Frank A. Bates, Student, University of Maine, Orono, Me.

William J. Cusack, Jr., Manufacturing Representative, St. Regis Paper Co., New York 17, N. Y., a 1948 graduate of Clarkson College of Technology.

Henry S. Dimmick, District Manager, SKF Industries, Inc., Philadelphia, Pa., a 1922 graduate of Massachusetts Institute of Technology.

Arne Dessen, Technical Manager, M. Peterson & Son, Moss, Norway, a 1930 graduate of the Norwegian Technical University.

Frank C. Duvall, Assistant Manager, Export Dept., The Black-Clawson Co., Middleton, Ohio.

Louis Georgevits, Chemical Engineer, Titanium Pigment Corp., New York, N. Y., a 1950 graduate of Columbia University.

Edward F. Goldmeyer, Group Leader, Oxford Paper Co., Rumford, Me., a 1930 graduate of the University of Cincinnati.

Morton F. Harris, Paper Mill Superintendent, Marcalus Mfg. Co., Inc., Paterson, N. J., a 1940 graduate of the Pratt Institute.

George H. Hopkins, Technical Director, Taylor Fibre Co., Norristown, Pa., a 1941 graduate of Ursinus College.

James D. Johnson, Technical Superintendent, Container Corp. of America, Chicago, Ill., a 1946 graduate of Purdue University.

Raymond E. Kilty, Sales Technician, A. E. Staley Mfg. Co., Decatur, Ill., a 1925 graduate of Tufts College.

Robert L. Knickerbocker, Assistant Superintendent, Mohawk Paper Mills, Inc., Cohoes, N. Y. Attended Lawrence College.

Leonard F. Lang, District Manager, Western Precipitation Corp., Los Angeles, Calif.

Robert E. Lehman, Technical Supervisor, Georgia Kaolin Co., Elizabeth, N. J., a 1948 graduate of Mercer University.

Walter C. Miller, Resident Engineer, Coos Bay Pulp Corp., Anacortes, Wash., a 1940 graduate of the University of Minnesota.

Donald A. Moran, Resident Manager, St. Regis Paper Co., Deferiet, N. Y.

Atushi Nishizawa, Production Manager, Sanyo Pulp Mfg. Co., Iwakuni-shi, Yamaguchiken, Japan.

Philip G. Noble, Technical Officer, Imperial Industries Ltd., Leathercloth Div., Hyde, Ceshire, England. Attended Huddersfield Technical College.

Betty Lou Otte, Librarian, Central Research Dept., Minnesota Mining & Mfg. Co., St. Paul, Minn., a 1947 graduate of the College of St. Catherine.

Ben E. Paul, Physicist and Statistician, Paper Container Mfg. Co., Chicago, Ill., a 1949 graduate of Illinois Institute of Technology.

Wesley H. Phillips, Chief Consumers' Representative, Marinette Paper Co., S. Glens Falls, N. Y. Attended Temple University.

Robert Rosenbaum, Chemical Engineer, Pollock Paper Corp., Middletown, Ohio, a 1948 graduate of the College of the City of New York.

Israel Rothschild, Office Manager, Vita Mayer & Co., Inc., New York, N. Y., a 1923 graduate of the University of Milan.

Frank G. Sellers, Paper Mill Control Engineer, Manitoba Paper Co. Ltd., Pine Falls, Man., Canada, a 1941 graduate of Queen's University.

Ronald Shutts, Student, New York State College of Forestry, Syracuse, N. Y.

Earl F. Stachel, Assistant Chief Engineer, American Coating Mills, Elkhart, Ind., a 1942 graduate of Michigan State College.

Paul Taylor, Chemical Engineer, Union Bag & Paper Corp., Savannah, Ga., a 1949 graduate of the Georgia Institute of Technology.

Benjamin A. C. von Weissenberg, Chief Engineer, Ab. Kemi Oy, Kemi, Karihaara, Finland, a 1925 graduate of the Technical University of Finland.

F. B. Wardwell, Student, New York State College of Forestry, Syracuse, N. Y.

Paul Weishaar, Student, New York State College of Forestry, Syracuse, N. Y.

Steve H. Wise, Junior Technologist, Wood Conversion Co., Cloquet, Minn., a 1950 graduate of the University of Minnesota.

Milton Yezek, Manager of Research and Quality Control, Carton Container Div., General Foods Corp., Battle Creek, Mich., a 1942 graduate of Pennsylvania State College.

Robert J. Zeitlin, Chemist, New York 33, N. Y., a 1947 graduate of the College of the City of New York.

William H. Zieseniss, Mechanical Engineer, Paper Mill Equipment Div., Combustion Engineering-Superheater, Inc., New York, N. Y. Attended Columbia University.

TAPPI Notes

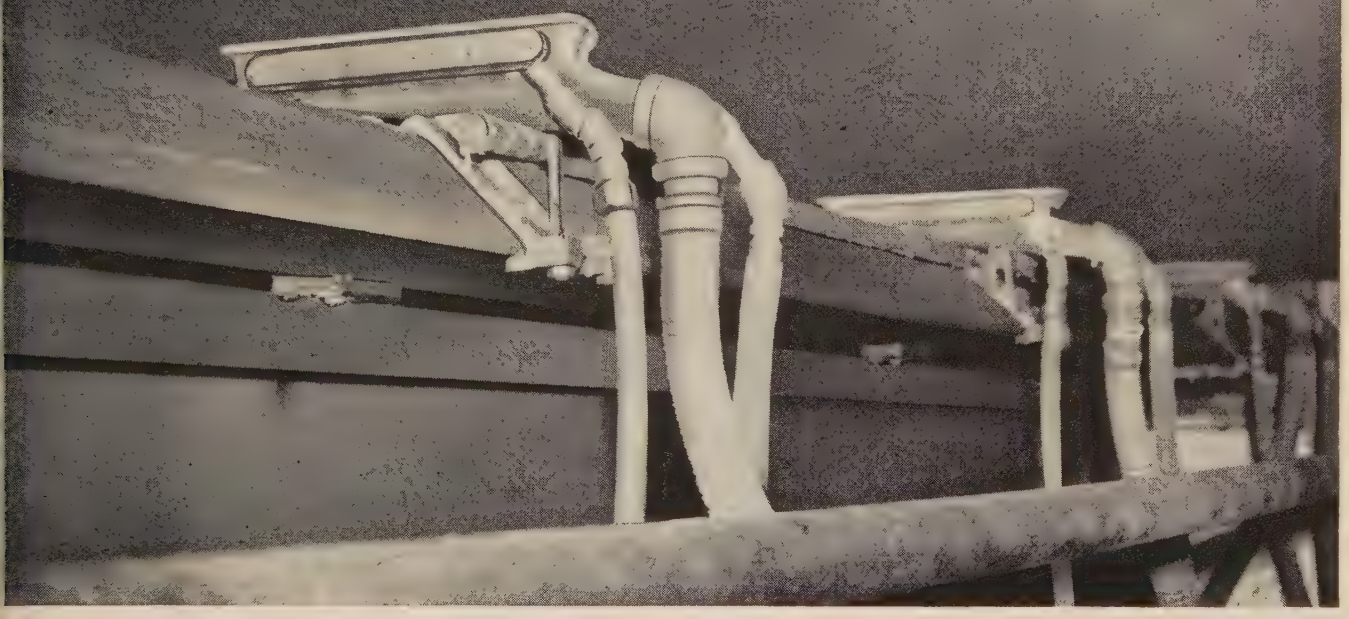
Betty Allender, formerly of the Windsor Locks Corp., is now purchasing agent for the Carolina Pulp Co., Rockingham, N. C.

Ernest F. Barker, formerly of Blake, Moffit & Towne, is now chemist for the Sorg Paper Co., Middletown, Ohio.

Richard T. Barnes, Jr., formerly of the International Nickel Co., is now a manufacturers representative, P. O. Box 227, San Francisco, Calif.

G. J. Bertrand, formerly of Papeterie de la Seine, is now

Today's Hard Working, Fast Running Press Felts
DEMAND
VICKERY FELT CONDITIONERS



Has felt conditioning kept pace with felt operation in *your* mill?

Modern Vickery Felt Conditioners equipped with "Jordan" type vacuum boxes and high speed gear boxes keep the felts continuously clean and absorbent however fast they run. The heavy production losses caused by midweek shutdowns to wash clogged felts are eliminated once and for all.

Now, you need Vickery Felt Conditioners more than ever. Make sure your Conditioners are equipped to meet today's conditions.

BIRD MACHINE COMPANY
SOUTH WALPOLE • MASSACHUSETTS

Vice-President in charge of the European Branch, Beloit Export Corp., Paris, France.

Charles A. Blodgett, formerly with the American Molasses Co., is now consulting engineer for Seaman & Seaman, 122 East 42nd St., New York, N. Y.

Carl A. Briggs is now in the Paper Sales Dept., of Fraser Paper Ltd., New York, N. Y.

Benton R. Cancell, formerly of the St. Regis Paper Co., is now Vice-President, Rhinelander Paper Co., Rhinelander, Wis.

Eugene H. Clapp is now President and Treasurer of the Penobscot Chemical Fibre Co., and Treasurer of Tileston & Hollingsworth Co., Boston, Mass.

Fred A. Coe is now Mill Manager of the West Virginia Pulp and Paper Co., Mechanicsville, N. Y.

Robert C. Dale, formerly of the Mid-States Gummed Paper Co., is now in the New Products Div., Minnesota Mining & Mfg. Co., St. Paul, Minn.

Paul A. Debois, formerly Director of Cobelpa, is now Administrative Director of Maprena, Brussels, Belgium.

William G. Dedert, Chemical Engineer of the Swenson Evaporator Co., has been transferred from Chicago to New York City.

Arthur L. De Spain, formerly of the General American Transportation Co., is now Project Engineer, Brown Co., Berlin, N. H.

Aubrey N. Dunn, formerly of S. C. Johnson & Son, Inc., is now Asst. to the Executive Vice-President in charge of Manufacture, Dunn Paper Co., Port Huron, Mich.

A. W. Duskin is now Technical Service Director of the Crossett Paper Mills, Crossett, Ark.

Floyd S. Edminston, Jr., is now Chief Operator of the Water Treatment Plant of the International Paper Co., Natchez, Miss.

Henry D. Fisher, formerly of the Institute of Paper Chemistry, is now in the Technical Control Group, Scott Paper Co., Chester, Pa.

John M. Fisher, formerly of the Manistique Pulp and Paper Co., is now Chemical Engineer, The Mead Corp., Chillicothe, Ohio.

Roland E. Fortier, formerly Pulp Mill Superintendent of the Central Paper Co., is now Chief Chemist, Potlatch Forests Inc., Lewiston, Idaho.

Arthur J. Gaio, formerly of John Waldron Corp., is now District Sales Manager, Baldwin Hill Co., Jackson, Miss.

Felix J. Gleason, formerly of Ware Laboratories, Inc., is now Paper Mill Superintendent, Johns Manville Corp., Manville, N. J.

Frederick W. Goertz, formerly of Triangle Publications, is now in the Sales Service Dept., Mead Corp., Chillicothe, Ohio.

Martin L. Gurley, Consultant, has moved from Pawtucket, R. I., to 91 S. Angell St., Providence, R. I.

W. N. Hall, formerly of the Standard Chemical Co., Ltd., is now with the Dominion Tar & Chemical Co., Montreal, P. Q.

Walter L. Hardy, formerly of Floyd A. Holes Co., is now General Manager of Leedpak, Inc., 294 Fifth Ave., New York, N. Y.

George A. Hermann is now President of the Hermann Mfg. Co., Lancaster, Ohio.

John H. Heuer, formerly of the St. Regis Paper Co., is now Manager, A.P.W. Products Co., Inc., Albany, N. Y.

George N. Hoover, Jr., is now Asst. Manager, in charge of Production, West Virginia Pulp & Paper Co., Mechanicsville, N. Y.

Miss Eleanor F. Horsey, formerly of the Glenn L. Martin Co., is now Technical Assistant, Mathieson Chemical Corp., Baltimore, Md.

Edward J. Howard is now Asst. Manager, Industrial Cellulose Research, Ltd., Hawkesbury, Ont.

Wiley L. Jennings is now Vice-President and Director, West Virginia Pulp and Paper Co., New York, N. Y.

Hans Jenssen, Librarian of the Food and Agricultural Organization of the U. N. has been transferred to Rome, Italy.

E. Langford Jones of the Hercules Powder Co., has been transferred from Hopewell, Va., to Wilmington, Del.

Marvin C. Jones, formerly of the Weyerhaeuser Timber Co., is now Midwest Representative for the Lockport Felt Co., Newfane, N. Y.

Raphael Katzen is now Asst. Manager of the Engineering Division, Vulcan Copper & Supply Co., Cincinnati, Ohio.

William H. Kennedy is now Staff Assistant to the Paper Mill Superintendent, Hammermill Paper Co., Erie, Pa.

Will J. Lessard, formerly of the B-F-D Div., Diamond Match Co., is now Engineer for Chas. T. Main, Inc., Boston, Mass.

Robert W. Lewis, formerly of the N. Y. State College of Forestry, is now with the Container Corp. of America, Manayunk, Pa.

Paul E. McCoy, Research Engineer, American Bitumuls Co., San Francisco, Calif., has been transferred to the Emeryville, Calif., plant.

John O. McCrystal, formerly of the Upson Co., is now General Plant Manager, Mt. Tom Div., Doeskin Products Inc., Mt. Tom, Mass.

William H. McPherson, formerly of the International Paper Co., is now with the Mead Corp., Chillicothe, Ohio.

J. B. Michon, formerly of Cie Nord Africaine de Cellulose, is now General Manager of Ceric, Paris, France.

B. D. Millidge is now with Thomas Bonar & Co. (Canada) Ltd., Montreal, P. Q.

Albert S. O'Brien is now Supervisor of the Paper Service Dept., Eastman Kodak Co., Rochester, N. Y.

R. Paradis is now Staff Assistant to the Superintendent, Brown Corp., La Tuque, P. Q.

Robert C. Paris, formerly of the Kalamazoo Vegetable Parchment Co., is now Lt. (J. G.) U. S. S. Marquette, Fleet Post Office, New York, N. Y.

Henry P. Petzold is now Asst. Mill Manager, Oxford Miami Paper Co., W. Carrollton, Ohio.

Richard A. Premo is now Technical Superintendent, Gould Paper Co., Lyons Falls, N. Y.

Warren R. Price, Consulting Chemical Engineer, is now located at 5751 N. Richmond St., Chicago 45, Ill.

T. Richard Probst, formerly of the Oxford Paper Co., is now Asst. to the General Manager, Oregon Pulp & Paper Co., Portland, Ore.

S. A. Salmonson is now Pacific Coast Representative for Chemical Linings, Inc., Homad Services Ltd., and Nukem Products Corp., Portland, Ore.

Arthur A. Scott is now Asst. to the General Director, Pulp and Paper Research Institute of Canada, Montreal, P. Q.

Carl A. Sholdebrand, formerly of the Publishers Paper Co., is now Superintendent, Spaulding Pulp & Paper Co., Newberg, Ore.

Curtis S. Walseth is now Senior Chemical Engineer, Union Bag & Paper Corp., Savannah, Ga.

Edward A. Wodka, formerly of the Lowe Paper Co., is now Chemical Engineer for the Paterson Parchment Paper Co., Bristol, Pa.

J. Howard Wright, formerly of W. C. Hamilton & Sons, is now Chief Chemist for S. Austin Bicking Co., Downingtown, Pa.

* * *

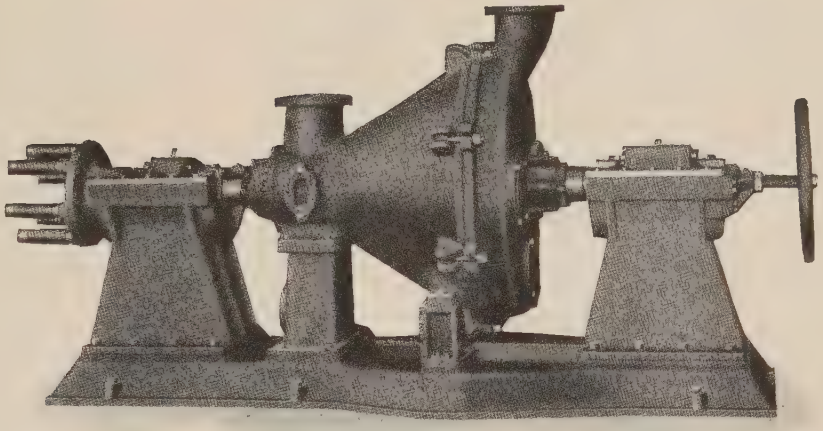
K. P. Sagreiya, Managing Director of the Ballapur Paper & Straw Board Mills Ltd., Nagpur, India, has succeeded S. K. Roy as official corporate representative in TAPPI.

G. M. Gilbert has succeeded A. C. Gilbert as the official corporate representative of the Gilbert Paper Co., Menasha, Wis., in TAPPI.

E. R. Wand has succeeded G. L. Carruthers as the official corporate representative of the Interlake Tissue Co. Ltd., Merritton, Ont., in TAPPI.

HERMANN *Improved* CLAFLIN

TIMKEN
ROLLER
BEARINGS



STAINLESS
STEEL
PACKING BOX
SLEEVES

WATER COOLED
PACKING BOXES

ONE-PIECE
CAST LINERS
WITH 3/8″ &
1/2″ WIDE BARS

No. 3 Hermann Claflin. Pin-Type or Fast's Coupling

BROWN STOCK REFINING

One No. 3 Claflin averaged 450 tons per day for thirty-days brown stock pumped from the blow tank to magnetic separators to Claflin (40–50 lbs. inlet pressure).

Discharge (40–50 lbs. pressure) to refiners to washers.

Claflin also used alone for several months with *substantial increase in yield* and minimum of foam trouble.

Second unit to be put in operation first of the year.

The first unit has been in operation for almost two years. It is direct connected to a 350 h.p. 400 r.p.m. motor. Second unit to be direct connected to a 200 h.p. 300 r.p.m. motor.

"CLAFLIN ADVANTAGES"

Pressure operation holds down foam to a minimum. Will handle coarse stock. Brushes with minimum of cutting. Low power per ton for work accomplished. Low initial cost.

THE HERMANN MANUFACTURING CO.

Also Mfr's. of TAPPI Standard Pulp Testing-Sheet Making Apparatus

LANCASTER, OHIO

J. H. Wilson, Purchasing Agent has succeeded N. H. Carpenter, Jr., (deceased) as the official corporate representative of the Muskingum Fiber Products Co., Coshocton, Ohio, in TAPPI.

R. A. Diehm, Executive Vice-President has succeeded Carl H. Luth as the official corporate representative of the Ward Paper Co., Merrill, Wis., in TAPPI.

* * *

Charles H. Vickery, Sales Manager, has succeeded Dwight E. Jones as the official representative of E. D. Jones & Sons Co., Pittsfield, Mass., in TAPPI.

F. A. Sanders, Vice-President has succeeded C. Frank Chiappe as the official representative of Frederick H. Levey Co., Inc., Philadelphia, Pa., in TAPPI.

Fred L. Crossman, President has succeeded A. Fred Crossman (deceased) as the official representative of the Lindsay Wire Weaving Co., Cleveland, Ohio, in TAPPI.

W. H. Shields has succeeded M. Rushmore as the official representative of Southern Clays, in TAPPI.

* * *

Frederic C. Clark Associates has moved its office from New York City to Manchester, Vt.

Asten-Hill Mfg. Co., is now located at Henry and Roberts Ave., Philadelphia, Pa.

The London Office of B. C. International Ltd., is now located at Greener House, 66–68 Haymarket, London S. W. 1, England.

Wyandotte Chemicals Corporation, Michigan Alkali Division, has moved its Cincinnati office to 825 Dixie Terminal Building, Cincinnati 2, Ohio.

The name of the Rumford Div., Heyden Chemical Co., has been changed to Rumford Chemical Works, Div. of Hulman & Co., Inc., Rumford, R. I.

Industry Notes

Six Maine concerns have taken $1000 memberships in the University of Maine Pulp and Paper Foundation. These are Fraser Paper, Ltd., Great Northern Paper Co., St. Croix Paper Co., St. Regis Paper Co., S. D. Warren Co., and Keyes Fiber Co.

* * *

The National Production Authority in the Department of Commerce is an organization about which the industry will hear more from month to month. William Henry Harrison is the head. Under him is the Industry Operations Bureau, headed by H. B. McCoy. Next in line is the Forest Products Division, headed by H. E. Holman. The Pulp, Paper, and Board Section is headed by W. L. Neubrecht.

The Pulp, Paper, and Board Section is responsible for pulp wood, wood pulp, prime manufacture of paper, paperboard, vegetable fiber, building board, paper wholesalers, exporters and importers; all converted paper and paperboard products (including envelopes) except printing and publishing and containers.

The Containers Section is headed by Charles A. Lewis which is responsible for shipping sacks and grocery bags, specialty and glassine bags, novelty bags, paper milk bottles, milk bottle tops and lids, paper cups and paper plates, fiber cans, fiber shipping containers, folding and set-up boxes.

* * *

The 20th National Packaging Exposition will be held on April 17–20, 1951 at the Auditorium in Atlantic City, N. J.

* * *

According to the statistics released by the Bureau of Labor Statistics recently the average injury frequency rate for all manufacturing industries in 1929 was 15.0 injuries per million man-hours. For the pulp and paper industry it was 16.4.

* * *

A commercial unit for the automatic and continuous emulsification of liquid rosin size has been designed by the American Cyanamid Company. Liquid rosin size is shipped as 70–80% solids, and before addition to the stock system must be diluted to 4% solids. Emulsification is necessary to disperse the water-insoluble free rosin present in the size so that it will distribute readily in the fiber furnish and floc uniformly with alum to give ink, lactic acid and water resistance to the paper. An improperly made emulsion may contribute to press sticking, felt filling, and nonuniform paper sizing. The general procedure has been to disperse the thick size by severe mechanical action in the batch-type process. The new Cyanamid emulsifier measures about 5 feet wide, 4 feet deep and 6 feet high. The unit can handle up to 12 tank cars of rosin-size per month. A dilute emulsion can be supplied as low as 1.5% concentration without need of additional storage facilities. Accuracy of dilute size is within 0.1% of the desired solids content of the emulsion.

* * *

Frank W. Egan & Co., Bound Brook, N. J., manufacturers of machinery for the paper converting and plastics industry have established their new offices in the recently acquired building at 115 Lincoln Blvd. This building will take care of

The new office of the Frank W. Egan & Co.

the expanded design and drafting departments as well as the laboratories for demonstration of various converting and drying equipment. The Export Division of the Company, formerly situated in New York is now located in Bound Brook.

* * *

The Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill., has just issued a new 12-page book No. 2354 on its Concentric Action Vibrating Screens.

* * *

The U. S. Dept. of Commerce has recently issued a 261-page cloth-bound book on "Market Research Sources, 1950." This is a guide for sales executives and market analysts. Copies may be obtained from the Superintendent of Documents, Washington 25, D. C., at $2.25 each.

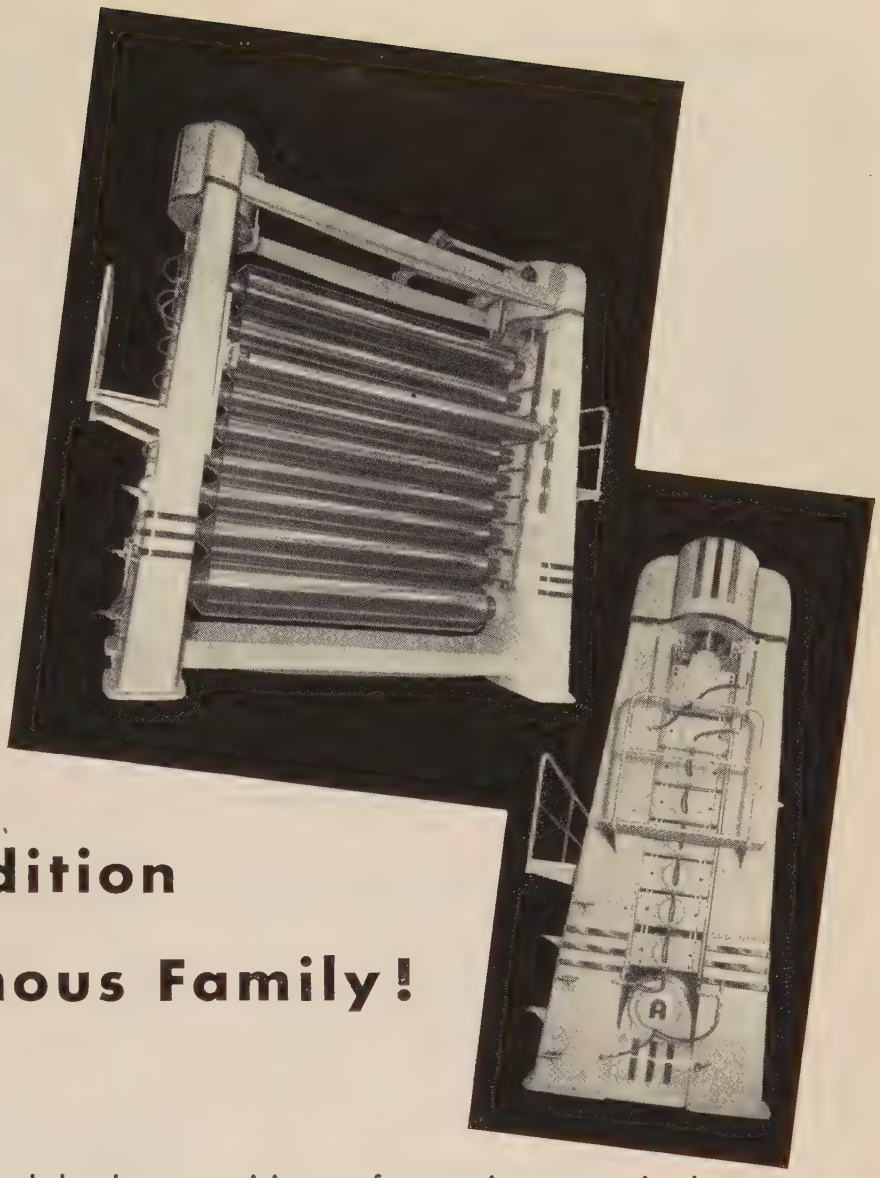
* * *

The Chamber of Commerce of the United States, Washington 6, D. C., has issued a booklet "Wage Supplements." This may be purchased at 50 cents a copy. This deals with hidden labor costs and how to figure them out. Such fringe costs as social security, unemployment insurance, pensions, life insurance, health benefits, rest periods, vacations, etc., amounted to 24 cents per hour worked.

* * *

The Hooker Electrochemical Co., will build a plant for the

Appleton Machine Calender Stack...



a New Addition to a Famous Family!

Appleton Engineers—designers and developers of the paper industry's finest supercalenders—have added a new Machine Calender to the famous *Appleton* line.

This greatly improved Calender Stack fills an important spot in the manufacture of high-finish papers. Designed for modern high-speed, high-quality production, the new *Appleton* Machine Calender offers operating and construction features that you'll recognize as exclusively *Appleton*.

The new Machine Calender is available in a wide variety of sizes . . . anti-friction type bearings are used throughout and you have a choice of pneumatic or hydraulic loading. This new unit is a real time-saver. Improved endwise method of removing rolls makes it possible to change rolls faster. And, it's a space-saver, too! Compact design requires a minimum of operating space in the paper machine line. Of course, you'll recognize the sturdy, welded steel frame as being styled after the closely allied *Appleton* Supercalenders.

Appleton stands ready to apply the very latest engineering advancements and accumulated technical experience to solving your individual high-speed finishing problems. Invite us in, won't you?

APPLETON MACHINE COMPANY
APPLETON WISCONSIN

CUSTOM-BUILDERS OF PULP & PAPER MILL MACHINES • WINDERS • ROBERTS GRINDERS • FINISHING ROLLS • REWINDERS

manufacture of anhydrous ammonia at its Tacoma, Wash., plant. This will make use of the hydrogen from the electrolytic cells. The ammonia will be used in the chemical and pulp and paper industries of the northwest.

* * *

The Rochester plant of E. I. du Pont de Nemours & Co., Inc., has asked suppliers of materials to bring attention to any materials which might possibly have been contaminated by radioactivity. Photographic materials are susceptible to radioactivity. Since this effect is cumulative, Geiger counters often fail to reveal it. Radioactivity may be present in paperboard and containers made from waste paper treated with luminous paints, tracer materials, packaged with other chemicals in multiwall bags, etc.

* * *

The General Electric Co., Schenectady, N. Y., has issued a new 8-page booklet on synchronous motor generator sets.

* * *

The Crossett High School, Crossett, Ark., has initiated a course in forest conservation and timber management for junior and senior students. This is the first course of its type offered in Arkansas public schools.

* * *

The Bag Division of the Union Bag & Paper Corp., produced 869.3 tons of finished products on October 24, a new day's record. The Pulp and Paper Division established a new record of 1348 tons of pulp daily and 1337 tons of finished products in October.

* * *

A new type of regulating device, the microsyn, has been developed by the Westinghouse Electric Corp., Pittsburgh, Pa. It is superior to step regulators in that it provides regulation in infinitesimal steps. It is more accurate than the Synchro-tie or selsyn types. It can produce a voltage proportional to the product of the square of a current and the angular displacement.

* * *

David E. Long Corp., 220 E. 42nd Street, New York 17, N. Y., has developed a comprehensive line of specially formulated protective coatings to meet most of the special and all of the routine requirements of the paper and pulp industry. A bulletin is available from the Company.

* * *

Eugene A. Ward has been appointed general sales manager of the Cameron Machine Co., Brooklyn, N. Y. He was assistant service manager from 1945–1948.

* * *

The Massachusetts Institute of Technology will conduct a special program in Food Technology, including food packaging from June 25 to July 13, 1951. Enrollment will be limited. Inquiries should be sent to Prof. Walter H. Gale, Room 3–107, M. I. T., Cambridge 39, Mass.

* * *

William Bond Wheelwright, 14 Hurlburt St., Cambridge, Mass., has in preparation a book on "Practical Paper Technology." The contents comprise lectures given at the Department of Paper Engineering, Lowell Textile Institute in 1950. These lectures were sponsored by the Boston Paper Trade Association. The price is expected to be $2.25 per volume. Special prices on quantity orders can be arranged with Mr. Wheelwright.

* * *

The Rhinelander Paper Co., has purchased all of the outstanding stock of the Great Lakes Yeast Corp., from ten sulphite pulp producing companies. The yeast plant is at Rhinelander, Wis., adjacent to the company's sulphite pulp mill. The purchase agreement provides that all technical information developed by Rhinelander will be made available to the Sulphite Pulp Manufacturers Research League.

* * *

Theo. A. Cook, Resident Manager of the Charleston, S. C., mill of the West Virginia Pulp & Paper Co., retired on December 1. Mr. Cook was with the company 40 years.

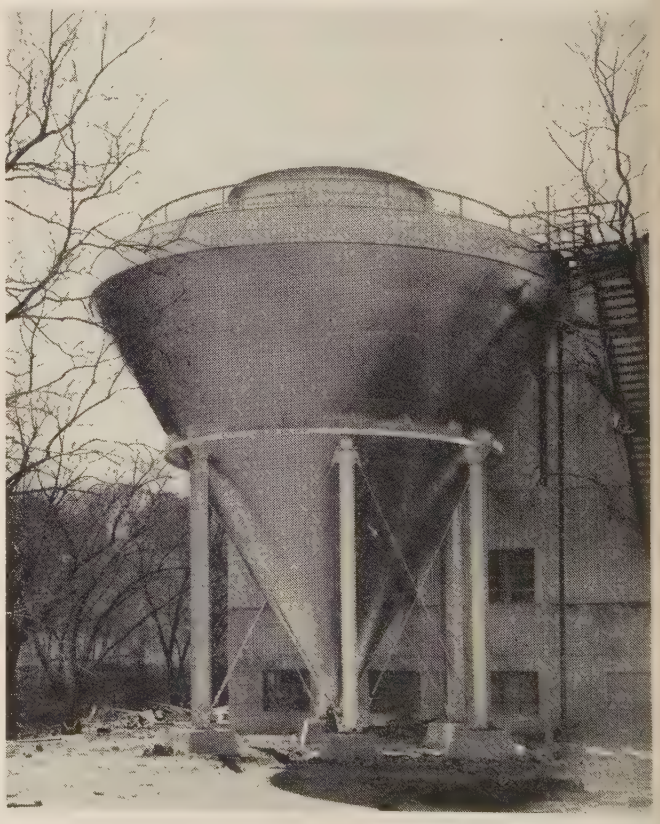
* * *

Two years ago Fleming & Sons, Inc., manufacturers of paper and paper products, installed a 1000-g.p.m. Marx Saveall at their Dallas, Tex., plant to reclaim the fiber in the white water from some of their paper machines. According to John C. Fleming, Vice President of the Company, it reduces the suspended solids, which are primarily pulp fibers, from 3.5 to less than 0.175 lb. per thousand gal.

The Fleming mill produces 250 tons of paperboard every 24 hr. White water from about one half of the paper machines and other papermaking processes flows into a sump and is pumped to the feed well at the top of the Marx Saveall.

The Fleming installation is a standard Marx unit, with an outer cone 38 ft. 6 in. in diam. at the top by 33 ft. high and an inner cone 26 ft. 6 in., diam. at the top, 12 ft. diam. at the bottom and 12 ft. 6 in. high. White water pumped into the receiving well overflows on to a deaeration cone 20 ft. 9 in. in diam. and runs off its outer edge into the inside cone of the saveall. The fibers and other solids in the water settle through the bottom of the inside cone and are drawn off periodically. The clarified water, minus most of the solids, rises between the two cones, runs over a weir into a trough at the top of the outer cone, and flows by gravity into a mill storage tank for reuse in the beaters and white water showers. When this tank is full, it overflows into the sewer.

The pulp fibers recovered by the Fleming Saveall installa-



Marx saveall at Fleming & Sons, Inc.

Stock Screening at Its Best!

Sandy Hill
Packer Superscreens*

Choice of 3 Types of Drives

Packer Superscreen* Model F

Electric steel casting roller shoes and steel forging cams require less horsepower, lessen vibration and noise, and lower maintenance cost. Replacing wooden blocks is eliminated.

Packer Superscreen* Model LH

This model has a totally enclosed roller shoe unit with continuous lubricating system. No oil leakage.

Packer Superscreen* Model T

The original Packer design with hardwood or composition toe blocks for the lowest cost installation.

The Discriminating Customer's Choice . . . as proven by our numerous installations during 1950! Among these:

- The most recent pulp mill installation in the far west!
- Two complete sets for board machines, both repeat orders . . . for a satisfied customer in Ohio, a leader in his field!
- A new board mill installation in Pennsylvania . . . after several years' study of equipment!
- A repeat order for an operator in Florida with years of experience with Packer Superscreens*

For more than half a century, the Packer principle of screening has been recognized as the best! The Packer Superscreen*, made only by Sandy Hill, presents to the industry increased efficiency and capacity and the elimination of dirt pull-through and plate breakage.

● **LOWEST OPERATING COST** ● **CLEANEST STOCK DELIVERY**
● **WIDEST CHOICE OF SCREEN SETTINGS** ● **EASIEST MAINTENANCE**

CONVERSION The roller shoe mechanism can easily be installed on existing Packer toe block screens at a minimum of time and expense.

Send for New Screen Brochure

* Trade Mark Registered

Sandy Hill Iron & Brass Works
Hudson Falls, N. Y.

Machinists and Founders Specializing in Paper and Pulp Mill Machinery

Manufacturers of
Adjustable Cylinder Vats
Cylinder Paper Machines
Pulp Grinders
Dandy Roll Drives

Pulpers or Kneaders, Voith
Thickeners
Quick Opening Gate Valves
Bertrams Flow Distributors
Bertrams Shakes

Neilson Slice
Feltless Wet Machines
"Selective" and Corner Drives
Fourdrinier Paper Machines
"Packer" Screens

Castings
Bleaching Equipment
Scofield Felt Conditioners
Cleveland Type Bearings
Shaker Screens

tion have a value of $18 per ton. This is considerably less than in mills making other types of paper where the pulp may be worth as much as $90 per ton.

The water supply for the Fleming mill is obtained from two deep wells at the rate of 1750 g.p.m. When the paper machines are shut down, the chests, white water pits, etc., are pumped out and the Marx Saveall is cleaned and refilled with clear well water, which is utilized during the start-up period after shutdowns. Inasmuch as the system has a relatively large capacity, the 96,000-gal. reserve in the saveall saves considerable time in restarting the mill. The draw down in the saveall is brought back to normal by fresh water from the wells in 30 to 40 min.

Cecil E. Thompson of Croton-on-Hudson, N. Y., was Consulting and Designing Engineer for the construction of the new Fleming mill of which the Marx Saveall is a part. The saveall was fabricated at the Birmingham plant and erected by foreman Lloyd L. Johnson.

* * *

The Canadian Pulp and Paper Association, Sun Life Building, Montreal, P. Q., has published an interesting 56-page booklet entitled "From Watershed to Watermark," covering the pulp and paper industry of Canada.

* * *

The Becco Sales Co., Buffalo, Station B., Buffalo 7, N. Y., is issuing an interesting monthly house-organ the "Becco Echo" Vol. I, No. 2 featuring the equipment used in the Becco Laboratories.

* * *

The Mallinckrodt Chemical Works, Mallinckrodt St., St. Louis 7, Mo., has issued an interesting brochure "An Outline of the History of Chemistry." This opens into a chart that can be framed.

* * *

N.P.A. order M-14 restricts the use of nickel, when used for maintenance, repair and operating supplies, during the first quarter of 1951, to a quantity by weight not in excess of average quarterly consumption during the base period of the six months ending June 30, 1950. Quarterly use up to 250 lb. is permitted for persons having a base quarter of less than 250 lb.

* * *

A Chemipulper unit was recently installed and started up at the Cenpa Company Plant, Begles, France. The equipment was manufactured and installed by Paper and Industrial Appliances, Inc., 122 E. 42 St., New York, 17. M. Comps, Technical Director of Cenpa, who was responsible for the Chemipulper Pulp Mill layout and the starting up of the project, is in the picture at the left. R. G. Goodwin, Engineer of Paper and Industrial Appliances, Inc., is in the picture at the right.

The Chemipulper was purchased by the Cenpa Company for this Plant expressly for the purpose of using waste woods for making pulps which would be suitable for their purposes. France is, at the present time, short of many grades of pulp and paper and Cenpa's ability to use the Chemipulper for the production of good grades of pulp from waste woods, is a step in the direction toward helping France become more independent of outside sources of pulp supply. The waste wood is all hardwood and comes from a sawmill operation. This wood contains approximately 20% moisture when it arrives at the Plant.

The Chemipulper operation's primary function is to produce pulp for corrugating board. The Cenpa Company also plan to use the high-yield hardwood semichemical pulps produced in the Chemipulper in other grades of paper, such as, liner board and bag paper furnishes.

The Chemipulper operation is using a kraft-cooking liquor with a low sulphidity. The low sulphidity is required because the Plant in its present location has an odor problem and is required by the neighboring City of Bordeaux to keep the sulphidity of their cooking liquor at a minimum. They expect to be able to remedy this condition in the near future and will then use a kraft liquor with a sulphidity more in line with what we are presently using in this country.

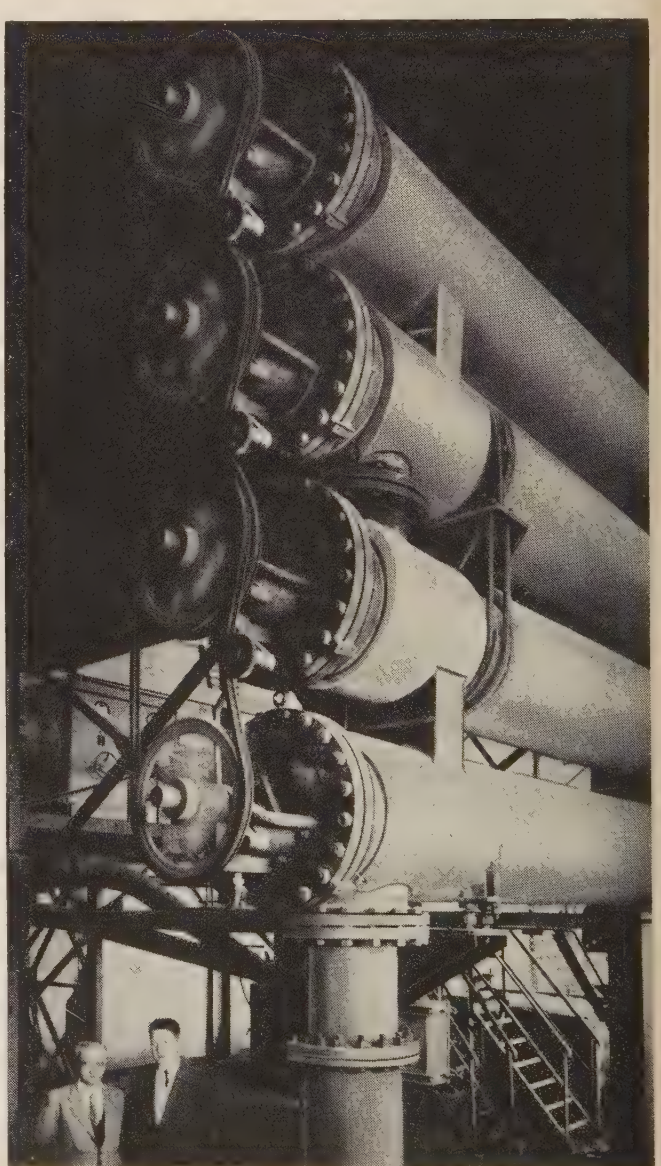
The waste wood is presently being cooked with a minimum of alkali for their corrugating board pulp and there is no recovery of the black liquor in this installation.

The Chemipulper stock is pumped directly from a cyclone to a Sutherland refiner and then goes directly to a fourdrinier wet-lap machine which drops the wet-lap pulp onto a conveyor which delivers the pulp to storage.

The Chemipulper operation supplementing Cenpa's present kraft-mill production will allow this Plant to materially increase their output of corrugating board, liner board, and bag paper.

The Cenpa Chemipulper installation is unique because the process from the wood chip to the wet-lap pulp is continuous and operates entirely without the use of any chests.

The Chemipulper installation at Cenpa was the first one to be started up in Europe and is the forerunner of several more installations in France and other European countries, several of which are to be started up in the coming year.



The Chemipulper installation in France

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W. A. CLEARY CORPORATION

NEW BRUNSWICK, N. J.

The Hudson Pulp and Paper Co., will install a second turbine generator and a new paper machine at its Palatka, Fla., mill. The General Electric turbine is rated a 400 p.s.i.g. automatic double extraction, condensing operation unit, 7500 kw., 4160 volts, 3600 r.p.m.

A G.E. sectional drive will also be supplied for a new 234-in. paper machine which will be used to produce kraft paper with a glazed finish. The wet-end of the new machine includes a pick-up felt so that the sheet is supported from the wire until just before it enters the first drying section. The drive for this machine is rated 500/2000 f.p.m., making it one of the fastest drives ever installed on this type of machine.

There will be a total of 18 driving units, ten of which will be speed regulated. This includes the creping drier and a Yankee drier, with a marking roll for making lightweight glazed paper. Another G. E. drive, having a maximum speed of 4650 f.p.m., will be installed on the machine winder, with regenerative braking on the unwinding roll. The company expects to complete its present expansion by next spring.

* * *

Following are the military specifications relating to flexible packaging materials. They may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

JAN-P-115, Compound, Sealing Dip, Coating
JAN-P-116, Preservation, Methods of
JAN-P-117, Bags, Interior Packaging
JAN-P-121, Barrier Materials, Greaseproof
JAN-P-125, Barrier Materials, Waterproof, Flexible
JAN-P-131, Barrier Materials, Moisture-Vaporproof, Flexible
AN-B-20, Barrier; Flexible Sheet, Moisture-Vapor
MIL-E-6060 (Formerly AN-E-1b), Envelopes, Moisture-Impervious (for aircraft engines)
MIL-C-6056 (Formerly AN-C-67b), Containers, Moisture-Impervious

* * *

The American Cyanamid Co., will consolidate its Chicago quarters in a new 100,000 square foot building in the Addison-Kimball District. 80,000 feet will be devoted to warehousing and 20,000 feet to office space. The annual rental will be about $1,000,000. The builders J. Emil Anderson & Son have organized the Kimad Building Corp., to own and manage the building. The building will be ready in March, 1951.

* * *

The Eastern sales offices of the Dorr Co., have been moved from New York City to Barry Place, Stamford, Conn. A branch office will continue to be located at 570 Lexington Ave., New York, N. Y.

* * *

Sprout, Waldron & Co., Muncy, Pa., in its house-organ *Better Fibers* for October, 1950 has published an interesting Report No. 4 on Semichemical Pulping.

* * *

Recently elected officers of the D. J. Murray Manufacturing Co., are A. W. Plier, Executive Vice-President and General Manager, D. C. Everest, Vice-President, C. L. Durkee, Vice-President and Sales Manager, W. A. Marquardt, Secretary, P. W. Hoeper, Asst. Secretary, and Grover Keeth, Asst. Treasurer. The other officers of the Company are F. C. Boyce, President, M. P. McCullough, Vice-President, and G. L. Ruder, Treasurer.

* * *

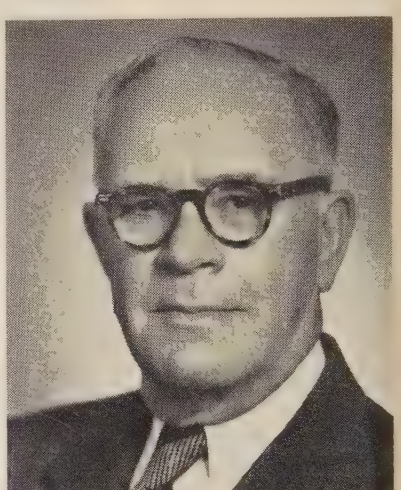
E. L. Oliver, Jr., has been elected Vice-President of Oliver-United Filters, Inc., Oakland, Calif.

OBITUARIES

James H. Allen

James H. Allen, vice-chairman of the St. Regis Paper Co., died at Pensacola, Fla., of a cerebral hemorrhage, following several months of declining health, on Monday, December 18.

Mr. Allen was 70 years old on November 19, being born at Neodesha, Kan., on November 19, 1880, the only son of Patrick C. and Lottie V. Jones Allen. His childhood home was in Park Bluff, Ark., where he graduated from high school in 1899. In 1902 he married Lutie Ella Laine, by whom he had three sons, James Laine Allen, William Frank Allen (both deceased), and Robert Hayes Allen who resides in Jacksonville, Fla. Mrs. Allen died in 1944.



James H. Allen

After graduating from high school he worked for the Hauf Allen Newspaper Agency. From 1904 to 1920 he was President of the Sterling Lumber Co. In 1906 he was Mayor of Bastrop, La. In 1920 he organized the Sterling Gas and Oil Co. of Bastrop, which aided in the development of the Monroe as fields and carbon companies. In 1921 he became vice-president of the National Lumber and Tie Co., which furnished cross-ties to the Union Pacific R. R. In 1924 he became associated with R. J. Cullen and with him promoted other pulp and paper companies, now the mills of the Southern Kraft Division of the International Paper Co. Following his stay with the Union Bag and Paper Corp. at Savannah, Ga., he went to Pensacola, Fla., in 1939 to start the Florida Pulp and Paper Co., which later became part of the St. Regis Paper Co. At the time of his death he was making plans for two more mills of this Company.

Mr. Allen took a wide interest in civic life. He financed the Pensacola, Fla., baseball team, he led to the establishment of a junior high school in Pensacola and gave a number of scholarships to college students. The Pensacola Kiwanis Club presented him with its Civic Trophy for his personal generosity, his leadership in public affairs, and his unselfish civic work. He represented the Pensacola mill in the Technical Association.

Andrew Howard Gilmour

Andrew Howard Gilmour, Superintendent of the C. H. Norton Co., Westchester, Conn., died suddenly at his home on November 17.

Mr. Gilmour was born in Rumford, Me., on Oct. 15, 1890, and worked as machine tender or superintendent for the Oxford Paper Co., Rumford, Me., New York & Pennsylvania Co., Johnsonburg, Pa., International Paper Co., Niagara Falls, N. Y., Racquette River Paper Co., Potsdam, N. Y., West End Paper Co., Carthage, N. Y., and Mazer Paper Co., Lansdown, N. Y. For the past nineteen years he has been superintendent of the C. H. Norton Co. He has been a member of TAPPI since 1933.

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TAPPI DIVISIONS AND COMMITTEES

Recent Reports of Activities

Mill Maintenance and Materials Committee

The following report is based on the committee meeting proceedings at the Fifth Engineering Conference of the Pulp and Paper Industry held at Cincinnati:

The committee Secretary, R. T. Barnes, Jr., advised that he had sent copies of TAPPI Specification E400-S-43 "Chromium-iron Castings for the Sulphite Pulp Industry," which had been so ably prepared by James A. Lee, to the committee members and to those members of the advisory subcommittee to whom the specification would be of interest, and that he had received approval of the specification from more than half of those to whom it had been sent. R. G. Macdonald advised that if such was the case, he should be notified to that effect so that the specification could be published.

Committee Chairman Parker advised that a real effort had been made to secure a chairman for the Subcommittee on Maintenance Costs, but that none had been found; consequently no subcommittee had been set up. He stated that he would be surprised if the Canadian committee with whom this subcommittee was supposed to work was not thoroughly disgusted with us. He went on to say that the project had not been abandoned and asked the committee members to assist in securing a chairman for this subcommittee. W. P. Nesbitt advised that the Canadian committee was now in the process of setting up a questionnaire to be submitted to the Canadian Mills, and that they would welcome assistance from our group in this work.

Committee Projects

Mr. Parker stated that A. I. Sippola had Project No. 341 "Lubrication Guide Covering All Pulp and Paper Equipment" well in hand. R. T. Barnes, Jr., reported that under Project No. 342 "Application Guide on Basic Specifications for Copper and Copper Alloys, Monel and Stainless Steel," the work on the Copper section was nearly completed and the work on the Monel and Stainless Steel section was progressing.

The committee discussed projects No. 343 "Welding Procedure and Welding Rod Specifications for Various Applications," No. 344 "Application Guide and Basic Specifications for Various Grades of Steel Tubing and Shafting," and No. 345 "Training Procedure for Maintenance Department Personnel," and decided that these projects should be placed on a list in the committee records so that they can be brought up for further consideration from time to time.

The committee decided to request permission to undertake as new projects the following:

Screening Capacities of Different Types and Designs of Screen Plates on Various Types of Stock
Procedures for Grinding Rolls of Various Compositions for Various Purposes
Compilation of a Check List for Mechanical Preventive Maintenance in Pulp and Paper Mills
Compilation of a Check List for Electrical Preventive Maintenance in Pulp and Paper Mills
Tabulation of Protective Coatings for Use Against Corrosive Conditions in Pulp and Paper Mills

Discussion Suggestions

Mr. Parker stated that in the committee records he had found many topics for papers that had been suggested from time to time, and that he had had a list made of these, to which he had added many subjects such as "Roof Maintenance" with the thought in mind that they would form a group from which the Round Table topics could be taken. He then asked each of those present for a topic for discussion to add to the present list. The following topics were suggested:

Methods of Surfacing Suction Box Covers and Forming Boards
Maintenance of Metal Sash in Pulp and Paper Mills
Use of Alloy Piping in the Sulphate Industry
Fume Removal over Sulphate Digesters
Maintaining the Electrical Crew Through Training
Maintenance of Industrial Trucks
Methods of Cleaning the Rubber Covering of Suction Rolls
Crowning of Rolls by Nip Impression

One of the committee members suggested that possibly the Forest Products Laboratories had test data on new materials. An effort is being made to ascertain if such is the case and a report will be made to the committee members later as to the result of the inquiry.

The round-table discussion meeting was devoted to a consideration of "Roofing Maintenance." George F. Hrubecky, Central Plant Engineering Manager of the Marathon Corp., Menasha, Wis., presented the following brief paper, following which there was a general discussion:

Roofing Maintenance—George F. Hrubecky

In appearing before you in a discussion of roofing maintenance I am not here as an expert on the subject but only with the intention of acting as a discussion leader, a moderator for a group of roofing experts that we have with us from the Johns-Manville Corporation, Barrett Company, Philip Carey Manufacturing Company, The Tremco Manufacturing Company, and others. The only thing I can add to this discussion will be a brief review of some of the types of roof that we, as engineers, are called on to maintain, a review of the types of roof decks underneath these roofs, and a review of the different elements in a roof that are likely to cause trouble or need special attention. The following is a list of the types of roof covering which we are most likely to encounter in our maintenance work.

1. Wood shingles
2. Tiles
3. Slate
4. Asbestos or composition shingles
5. Single-ply roll roofing
6. A build-up roof with no gravel
7. A build-up roof with gravel
8. Metal roof

It is very likely that this discussion will lead primarily through problems concerned with build-up roofs, but unless you are associated with a most modern plant that has no outlying sheds or old-fashioned buildings, you are very likely to encounter maintenance problems on other types of roof covering, and I wish that you would bear in mind these other types and ask questions pertinent to them even though we may not have experts on those types of roof covering present. I do not believe that there is any point in dwelling on or explaining these classifications of roofing coverings because they are too familiar to you all.

The second outline is the type of roof deck which we are most likely to encounter.

1. Wood
2. Metal
3. Concrete (which includes haydite or any other lightweight concrete aggregate)
4. Gypsum
5. Kaylo
6. Foam glass

Roof coatings may be applied directly to these decks or may be applied to insulation material that has been placed on top of these decks.

The third item that we should review are some of the elements that make up a roof which may determine the type of maintenance to be done.

1. A pitched roof. In connection with this we have the treatment of the ridge of the roof
2. A flat roof
3. Valleys
4. Parapet walls
5. Roof drains and gutters
6. Roof projections such as skylights, ventilators, etc.
7. Fastenings to roofs
8. Expansion joints

There are many other ways to break down these outlines and subdivide them, but I believe fundamentally that these elements will indicate the types of problems that we have.

I believe the next thing to review is the typical procedure most of us go through in the line of maintaining or preparing roofs that are in various states of wear or disrepair.

1. Roof patching
2. A mop coat on roof
3. A cap sheet mopped on top of the roof
4. Reroofing when needed
5. The rehabilitation of a roof deck

I believe that this review of the types of roofing, roof deck, the elements of a roof, and the steps we will likely take in repairing these roofs, leads logically to a series of questions in your minds, and I think we should take the position that none of us are experts and ask whatever question does come to mind in connection with any of these types of roofings—not neglecting some of the more old-fashioned or primitive types that must be repaired. May I have some questions from the floor?

Statement: Over the wet end of a paper machine there is a reinforced concrete roof deck in which the beams are cast integral with the roof deck. Over the deck there is no insulation. In this installation the concrete on the underside of the beams spalled off, exposing the reinforcing rods.

Answer: Similar trouble had taken place over a settling basin, and the cause of the trouble had been attributed to the extreme changes in temperature which varied from −35 to +85°F. In this instance the damage had been corrected by thoroughly cleaning up the remaining concrete surface and replacing the missing material with cement put in place by the guniting method.

Answer: Repairs could be made by guniting or by ironiting. However, it was suggested that before repairs were made, a diligent search should be made to find the reason for the damage and correct the reason. In the case under discussion, there are two quite common causes for such damage, (1) moisture may enter the concrete, either from the underside of the deck or through the roofing, and freeze, thus breaking patches of the concrete loose and forcing it away from the member, and (2) the reinforcing rods may have been placed too close to the surface when the beams were made, thus allowing moisture to reach them producing rust which built up pressure and pushed off spalls. It was suggested that an effort be made to determine if moisture was coming through from the top of the roof deck. If so, the damaged spot in the roofing should be found and patched. On the other hand, if moisture was getting into the structure from humid conditions below the deck, repairs restoring the beams to their original contour should be made, then a vapor seal should be installed on the underside of the roof deck to keep moisture out.

Answer: Under the temperature conditions given, moisture must be present in the air directly under the roof slab. It was suggested that the roof deck be insulated to prevent condensation

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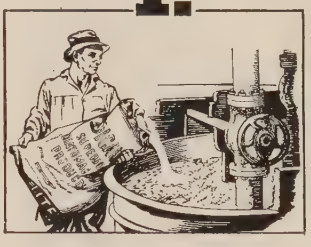
1.



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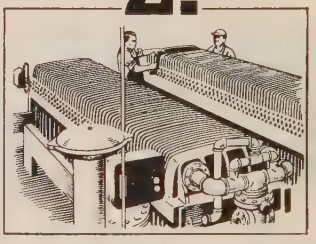

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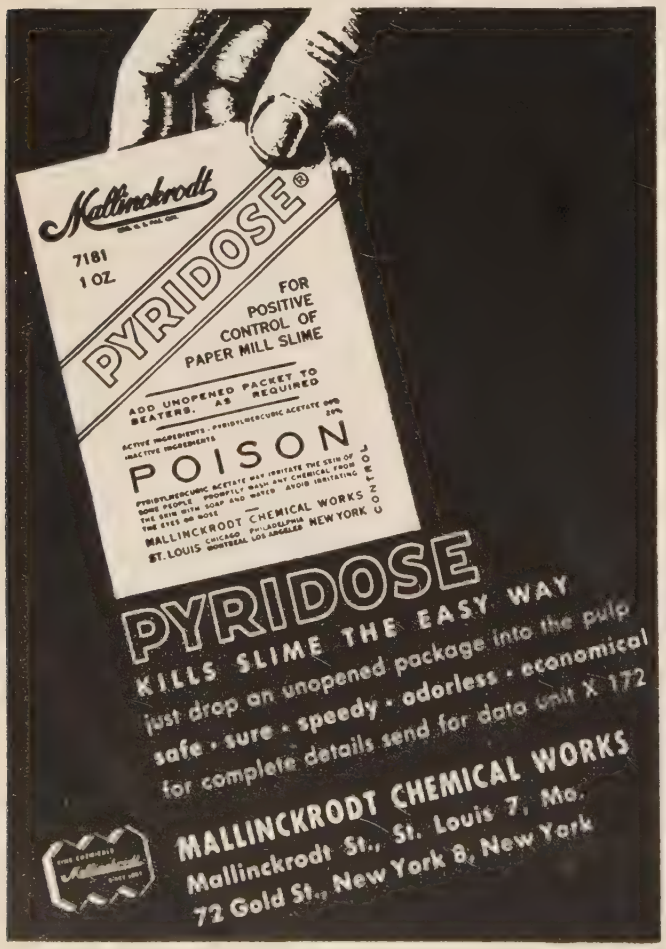
Write for Bulletin No. 1400. It describes the motor-driven and hand-operated models as well as other Gurley paper-testing instruments. W. & L. E. Gurley, Station Plaza & Fulton Street, Troy, New York.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taking place on the underside of the slab with the attendant possibility of moisture getting into the deck, freezing there, and setting up unusual stresses.

Answer: Repairs had been made to the beams under discussion by the guniting process, but after three or four years the spalling again took place.

Answer: A professor in concrete construction had pointed out that when making reinforced concrete, the water in the concrete permitted the cement to react chemically with the film of rust on the reinforcing rods to form a protective coating that prevented further rusting. If in placing the concrete, the rods were dirty or the concrete was so dry that there was not enough water in it to set up the chemical reaction, the rods did not receive the proper plating, hence rusting of the rods could occur at a later date if moisture penetrated the mass, thus creating spalling from the pressure set up by the rust.

Answer: Possibly the concrete beams were overstressed thus cracking the concrete and permitting spalling.

Answer: The latest attempt to clear up the trouble in these beams had been to install a vapor seal.

Statement: On a 3-in. Wolmanized plank roof, over which there was 1 inch of fiberboard insulation, wood crickets or saddles had been built to turn water to the roof drains. In this case the insulating material had been carried over the saddles to the parapet wall. Temperatures ranged from −35 to +85°F. The humidity under the roof deck was very low. Some few years after the installation had been made it was found that the wood saddles had completely rotted out and they had to be replaced. Failure of the wood saddles was attributed to the roofing material having shrunk away from the parapet wall allowing moisture to enter through fine cracks between the wall and the roofing material. In making the repair, thermofill had been used.

Answer: Where the shape of saddles had had to be changed to get proper drainage, Amiesite had been used with excellent success as it never became completely rigid. Heat from the sun cured any cracks that tended to develop, and there was nothing present to deteriorate.

Answer: For the temperature range quoted, experience indicated 1-inch insulation was not sufficient to give satisfactory protection. In many instances using this type of construction it had been found that the insulation had been stopped short of the parapet wall for the installation of the cant strip and that trouble had developed. The preferable method for this type of installation is to carry the insulation to the parapet wall and then put the cant strip over the insulation.

Answer: Saddles made of cinder concrete impregnated with emulsified asphalt and thoroughly packed down have proved to be very satisfactory.

Statement: On a $2^{5}/_{8}$-inch wood deck carried on wood beams there were ventilating fans over the driers and skylights over the wet end of the machine. The fans took air out of the building, which was replaced with air entering through the machine-room windows and doors. Investigation showed no air entered through the skylights. In this installation the deck over the wet end rotted out from the center of the plank to the outside surfaces and the beams carrying the deck from the top surface down. In the area where the trouble developed, both high temperature and high humidity were present. It was believed that these factors caused condensation to take place within the deck plank at the point where the dew point occurred, and that as the temperatures changed both under the deck and above the deck the location of the dew point changed. It was also thought that condensation took place between the top side of the beam and the underside of the deck. To correct these conditions ventilating fans have been installed over the wet end of the machine to remove the dead hot humid air.

Statement: On a monitor which ran the full length of a building, precast concrete slabs laid on steel trusses had presented no spalling problem. However, in this case there were a series of ducts in the roof through which warm dry air was distributed to the room.

Answer: It had been found that by turning the discharge openings on large pipe coil unit heaters to discharge their air upward under the roof deck, instead of downward toward the floor, 75% of the condensation on the underside of the roof deck had been eliminated.

Answer: Little trouble had been experienced with machine-room and pulp-mill roof decks made of 3-inch wood, monolithic concrete, or precast concrete slabs. In 1937 a 3-inch Wolmanized wood roof had been installed which had a J. O. Ross unit under it, and no trouble had been experienced with it. However, in screen and diffuser room roof decks, troubles had been experienced, but since lightweight precast concrete slabs had been used, the troubles had disappeared.

Answer: The use of steam to heat air to keep roof decks dry has been found to be economical.

Answer: Hot air had been found to be very useful in correcting condensate or sweating conditions.

Question: Had it been found practical to break large areas of roofing up into several sections?

Answer: Ninety-eight per cent of all roof troubles start 6 inches from the edge of the roof, so dividing the roofing material into sections is not necessary or particularly practicable.

Statement: An insulated concrete roof had made the machine room so hot that the employees found the condition unbearable, but when ventilating fans were installed in the side walls the condition was corrected.

Statement: A roof installed in 1923 was described as consisting of 4-inch steel purlins to which were bolted 2 by 4-inch nailers, over which was laid a 3-inch tongue and grooved deck covered with a built-up roof. Three years ago, when the nailers started to fall off it was discovered that the bolts had rusted off and that the deck had started to rot upward from over the nailer; otherwise the deck was in good shape. In this case new creosoted nailers were installed and air was blown under the deck so that now it remains dry.

Question: Can corrugated asbestos roof decking be insulated, and if so can it be done on a steep roof?

Answer: Corrugated asbestos roof decking can be insulated. However, the corrugations must first be filled with a mastic made of asphalt, sand, and cork fiber, to produce a smooth surface. Then a 15-pound felt should be installed for a vapor seal followed by 2 inches of insulation and a 4-ply built-up roof. Such a roof was suitable for pitches up to a maximum of $2^1/_2$ inches per foot. This type of roof weighs about 8 pounds per square foot. On a flat roof the corrugated asbestos deck can be fastened very well and easily by the Nelson Stud Welding method.

Question: What is the steepest pitch on which gravel can be used?

Answer: Two inches per foot was considered the maximum when using asphalt.

Answer: With steep roof pitch gravel can be used up to a pitch of 6 inches per foot. Installations of pitch and gravel have been made on circular roofs where the pitch and gravel held, but it certainly is not recommended for such use. It is also known that steep roof pitch and gravel have been used on roofs having pitches up to 9 inches per foot, but again it is not recommended, for under the heat of the summer sun the pitch will gradually work toward the gutter or eaves taking the gravel with it and leaving the felts at the ridge exposed.

Question: What steps should be taken to eliminate ice on roofs?

Answer: If roof insulation is correct ice can form on flat or low pitch roofs. If ventilating fans are located in the roof they should be arranged so that the air from them will sweep the roof.

Answer: The pitch of the roof should be changed so that any snow melt would run off before freezing could occur.

Answer: Where freezing takes place at the eaves, soil heating cable may be installed along the edge of the roof to keep the eaves warm enough to prevent ice forming.

Question: What steps should be taken when roof drains occur at a point higher than the adjoining roof?

Answer: New saddles or crickets should be constructed of some impervious material in such a manner that the drains would occur at the lowest point and then build up the roof over the fill.

Statement: Where roofs must be traveled over or where work must be done on roofs, there is always the ever-present danger of puncturing the roof with subsequent water damage. It has been found practical to work out a system whereby employees are commended for reporting any puncture they may have made instead of being reprimanded, for by having the damage reported promptly additional damage could be avoided.

Statement: Roof work (work above the deck) should be undertaken only after consultation with a roofing manufacturer's representative and several recognized and approved roofing contractors.

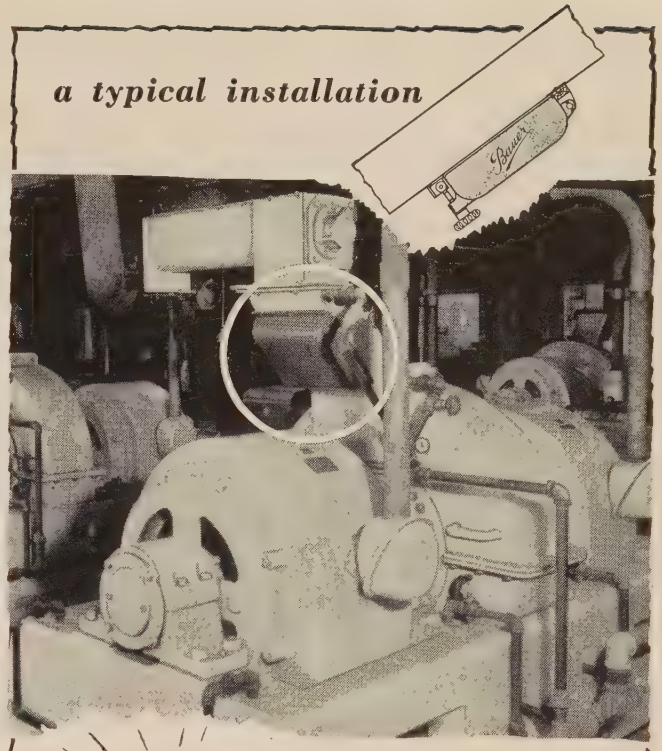
H. F. Parker, *Chairman*
Mill Maintenance and Materials Committee

Mill Design and Economic Aspects Committee

No meeting of the Mill Design and Economic Aspects Committee was held at Cincinnati due to the sudden death of the Chairman, Alvin H. Johnson, on Saturday prior to the Fifth Engineering Conference.

Roland A. Packard, Executive Vice-President of the Holyoke Machine Co., agreed to accept the chairmanship on a temporary basis. At the Conference Mr. Packard read his Interim Report of the "Mill Engineer's Selection of the Paper Machine Drive." This followed Mr. Packard's presentation

a typical installation



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at the Boston Conference a year earlier. Mr. Packard's Report follows:

Mill Engineer's Selection of the Paper Machine Drive

Part I of this report delved into the interesting history of this subject beginning 100 years ago. The maintenance of constant speed, easy adjustment to a variable draw, and a trouble-free mechanical drive was the constant prayer of early papermakers. Constant tension between sections was a later refinement which became mandatory as specifications on paper became more and more exacting. The Marshal train and the variable speed single-motor drive, the steam engine or turbine connected to the variable speed shaft, and the flat or V-belt connections to the "Iron Box" corner drive were described. The thinking of some engineers brought them into the realm of sectional motor movement. Hydraulics were not forgotten in the ingeniously designed plunger motors to give constant displacements and variable revolutions per minute. Curves were developed showing the speed ranges for manufacturing different kinds of paper as well as different types of drives.

The continuation of research on this subject has developed into an interesting series of channels of information from chief engineers of paper companies as well as paper machinery manufacturing shops. The author considers himself merely a focal point toward which the thoughts and aspirations and accomplishments of scores, yes, hundreds of pioneers, who have worked so earnestly to satisfy the constantly increasing demands of papermakers can be directed.

The mere thought of a paper machine usually flashes into mind one of the largest combinations of rolls, wires, and felts ever developed by man in any industry. It uses heat, pressure, vacuum, electricity, mechanics, hydraulics and all of these in various complex combinations. Mechanical parts have to move in controlled precision particularly in regard to speed and draw. Yet, there are medium-sized machines which fit the requirements of production of a certain paper or board. Increase in width, speed, and size of the machine, particularly the drier section, often takes courage and many times a good-sized pocketbook.

These exacting demands must be satisfied in the total drive selected. Therein lies the necessity for freedom of thinking. That thinking is usually predicated upon the past experience of the party responsible as well as his associates. When an engineer or engineers from outside are called in, and advice given, such advice is often derived from a background of partial familiarity with the immense number of combinations which have been built into the drives of paper machines. An error in judgment can be costly. As one engineer of a large paper mill recently expressed it, "There are so many variable factors to be considered in the selection of paper machine drives, and so many different systems of accounting for the maintenance costs of such drives, that we appreciate the tremendous work involved in properly evaluating the data which can be gathered. We wish you success in preparation and presentation of your report to TAPPI, and wish to tell you we are genuinely glad to be able to assist you in these efforts in TAPPI to increase the fund of knowledge of the paper industry." Indeed expressions like these are heartening.

Fifty-five personal letters have been written and sent to all parts of the country to engineers and papermakers as well as paper machinery manufacturers. The wide variation in some of the answers received will require a more extensive survey than at first contemplated; but the author is willing to put his time into the project because it is felt that this is a task overdue, as one engineer expressed it. Therefore those of you who have not received a letter (and I am sure it was no intended slight) and feel that you have some constructive information to impart, would you take home the tentative outline which has been distributed, as well as the form to be filled out, and mail it to the author as soon as convenient. This will be doing a constructive act for your brother papermakers and engineers. The author would like to emphasize that final reporting of findings will in no way divulge the source of information. However, where desirable I would like to obtain permission to add the names of authors in a list to be placed at the end of Part II. The usual course will be the melding together of items so that averages are shown. Where great divergence of figures are submitted, and there is much of this thus far, a special study will be made as to the causes and special treatment given.

It is believed that the ramifications of this project can be a parallel effort to the work which has been done and is still being worked on by Albert S. Goodrich, Chief Engineer of the Hammermill Paper Company, covering the power requirements for different sections of the paper machine.

Some preliminary observations which are of a character that there is little chance of contradiction when more extensive returns come in are being submitted to you.

On the subject of production efficiency all of the returns thus far show it to run between 99 and 100% with several of them close to the latter figure.

Another interesting item is the ratings of satisfaction derived from the operation of the sectional motor drives. Earlier installations have been labeled "fair." Later, this has turned to "good" reflecting the improvements which have been designed into them as a result of operating experiences. Two machines with separate motors on each section were described as "excellent."

The experience shown on the hypoid flat-belt drive is usually excellent. Older drives of this type have been just fair or good. In some cases it has been admitted that mistakes have been made in the selection of parts of the drive and alterations subsequently made, usually resulted in improvement.

In the relation between flat-belt and V-belt drive, there is little that is conclusive thus far. Even on large machines where flat-belt drives are used, satisfaction has been expressed. The additional strength which has been designed into the V-belt of late years has come into usefulness in application to some of the larger power requirements as bigger machines are built.

One interesting observation on a sectional drive is the use of a differential voltmeter which was installed between the couch and first press (pickup felt is used) which is employed to measure the felt tension at the pickup point.

This interim report is being written in the very shadows of the large number of paper mills in the City of Holyoke, Massachusetts, once called the center of the papermaking industry of America. Progressive management in this area and in the western part of the state is carefully analyzing possible good which can come from replacement of old open mortise gear drives. When production efficiency calculations will have been received and averages set up, this type of management will have another yardstick to gage its production efficiency based on machines hours down.

In conclusion, it is well to realize that nothing has real existence until it is known. As an engineer thinks, that is existence to him at the moment of his thought. We work to live that we may live to know. Working together, we should uncover and average the consensus of thoughts from the outline handed to you. Thus the hope is that as many of you who can, will avail yourselves of the opportunity to send in machine-drive data as well as suggestions of any additional items or studies on the subject of paper-machine drives.

ROLAND A. PACKARD, *Chairman*
Mill Design and Economic Aspects Committee

Steam and Power Committee

The principal effort at the Steam and Power Committee Meeting was devoted to selecting the subjects to be considered at the Sixth Engineering Conference to be held at Savannah, Ga., next fall.

The main session will feature:

"Materials and Design of Piping Systems for High-Pressure High-Temperature Service."
"Gas Turbine Applications in the Paper Mill."
"Outdoor Power Plants."

The round-table discussion session will feature

"Cinder Collection," by G. W. Bollinge of the West Virginia Pulp & Paper Co.
"Education of Power Plant Operators"—M. F. Schnaufer, Detroit Sulphite Pulp and Paper Co.—Discussion Leader.
"Relative Merits of Air Preheaters and/or Economizers."

The Committee decided to get started on some long-range projects and the collection of information for the TAPPI Data Sheets and reference books.

C. J. Sibler agreed to continue as Chairman of the Committee for another year.

W. C. BLOOMQUIST, *Secretary*
Steam and Power Committee

Electrical Engineering Committee

Report on Motor Applications

Ray Foster presented the report of our subcommittee on the "Application of Motors in the Pulp and Paper Industry" during the general engineering division meeting Wednesday morning, October 4. This subcommittee consisted of:

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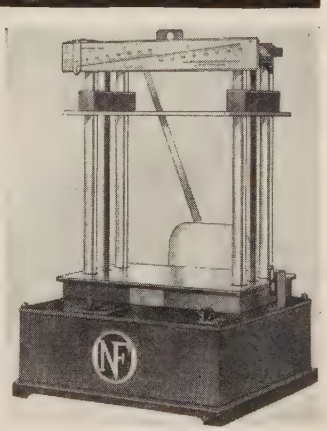

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R. F. Sorenson, *Chairman*, Union Bag & Paper Corp., P. O. Box 570, Savannah, Ga.
E. L. Cowan, Gaylord Container Corp., Bogalusa, La.
Ray Foster, Champion Paper & Fibre Co., Canton, N. C.

The report is considered as preliminary by the subcommittee, but does an excellent job with a tough subject. There was much interest in it and we did not have enough copies to begin to take care of the need. This subcommittee certainly deserves the thanks of our committee and all mill engineers.

After Mr. Foster presented the report, J. C. Lynch of Hammermill Paper Company gave a very good detailed discussion which he prepared on short notice. Charles A. Shoudy, General Superintendent, West Virginia Pulp & Paper Co., Charleston, then discussed the paper broadly emphasizing the importance of the subcommittee's work to mill management and production.

To make the report as representative as possible copies of it will be sent to mills throughout the country and to electrical manufacturers, asking for discussion and comment. This information will then be considered by the subcommittee and the report modified as judgment indicates. Following this, it will be submitted to TAPPI for publication, and suitable data sheets prepared from it. This is a major contribution to electrical engineering in paper mills. Committee members who were not present at the meeting will be sent copies of this report in about 3 weeks.

Report on Fourdrinier Power Requirements

The preliminary committee report on "Power Requirements of Fourdriniers" was prepared by W. Mikelson, General Electric Company, Schenectady, N. Y., and was presented by him during the Electrical Engineering round table Wednesday afternoon. The tests which provided a basis for it were conducted by five different mills. Messrs. Goodrich and Lynch of Hammermill Paper Company obtained test data which were particularly significant and complete, and also contributed in determining the test procedure. Other data came from St. Regis Paper Company (Pensacola and Tacoma) and the Ontario Paper Company, Thorold, Ont.

Mr. Mikelson's method of analysis was examined and seemed to meet with general approval. Some suggestions were made on the test procedure which Mr. Mikelson said he would take under consideration.

It is felt that additional data are needed for this study before the report is submitted for publication. It is hoped that this can be obtained within the next few months so that the report can be published next Spring. Meanwhile, it was decided that the committee recommend the continued use of the couch power constants given in its general report by A. S. Goodrich (*Tappi*, 33: no. 3, March, 1950), unless unusual suction box conditions indicate that Mr. Mikelson's preliminary data should temper the results.

As a result of the round-table discussion of test procedure it will be modified somewhat and copies of it will be sent to certain mills, who we hope will cooperate, asking for tests to be made. Ray Foster of Champion at Canton, R. F. Sorenson, Union Bag and Paper Corp., Savannah, John Osborne of Crossett, and Irving Witham of the Byron Weston Co. have already agreed to make tests. Mr. Goodrich points out that the actual taking of the tests is only a 15-minute job once the setup has been made, so that it can be done during a wash-up. Any committee members who want to participate are welcome and their data will be very useful. (They may be surprised at the results!)

Power Requirements

1. It was decided to continue the study of fourdrinier power requirements. A good start has been made, but additional data are needed and the cooperation of committee members is requested. It is hoped that the present report can then be amended and published in *Tappi* early in 1951.

2. It was decided to study the power requirements of press sections next as part of our continuing investigation on paper machines, sending a questionnaire to representative mills. This would include only open presses and not the first main press on cylinder machines. Mr. Baker was appointed chairman of a subcommittee to do this. He will appoint his committee members as required. His report will be presented at next year's TAPPI Engineering Conference.

3. The power requirements for supercalenders were discussed and Mr. Baker will head a subcommittee to do this, appointing his committee members as required.

Report on Application of Cable

4. Mr. Mortenson was appointed chairman of a subcommittee on Cable, appointing his committee members as required. F. V. Calvert, General Electric Company, Cleveland; A. P. Schnyder of Ebasco Services, Inc., New York; and a representative of the Simplex Cable Company were discussed as possible members. This report will be presented at next year's meeting.

Papers for Association Magazine

5. The committee also decided to do as much as it could to encourage papers on electrical and related subjects for publication in *Tappi*, asking the authors first to submit such papers to it for review and noting in the magazine (by a suitable footnote) such papers as were sponsored by the committee.

The committee on the Pulp & Paper Industry of the American Institute of Electrical Engineers has prepared excellent reports on supercalenders and winders. Our committee is going to ask this group to release these reports to us so we can review them and publish them in *Tappi*.

Membership

6. The committee also decided to try to increase its membership among paper industry people by two or three more, and suggestions from present members will be very welcome. Inactive members will not be carried on our roster.

G. W. Knapp, *Secretary*
Electrical Engineering Committee

Materials Handling Committee

A. P. Schnyder presided at the meeting of the Materials Handling Committee.

The following members were appointed to represent your Materials Handling Committee in territorial divisions indicated:

F. D. Helversen—California, Oregon, Washington
W. A. McKenzie—British Columbia
A. T. Hurter—All of Canada, except British Columbia
C. E. Patch—New England States
K. C. Neunfeldt—New York, Pennsylvania, Ohio, Maryland, Virginia, West Virginia
S. D. Frost—Southern States—North Carolina to Texas
W. R. McNally—Michigan, Wisconsin, Minnesota, Illinois

This geographical representation is intended to stimulate interest and to provide increased cooperation between the Materials Handling Committee and the local sections of TAPPI, as well as throughout the mills in the respective areas. It is hoped that the local chapters and the mills will take full advantage of this contact setup and that mutual benefits will accrue.

It was further decided that the Materials Handling Committee would sponsor two papers for the TAPPI Engineering Conference to be held at Savannah, Ga. in 1951. The subjects to be covered on these papers are:

1. "Use of Industrial Trucks in Paper Mills"
2. "Log Transfer Problems and Solutions"

On the first paper, it was suggested that because of the scope of the subject, it would be preferable to have a representative of a truck manufacturer present this paper.

With reference to the second paper, it was suggested that material and photos be submitted by all members, and that a speaker be selected at a later date.

W. R. McNally, *Acting Secretary*
Materials Handling Committee

Engineering Research and Machine Design Committee

In the regular portion of the program to the Engineering Research and Machine Design Committee, at the Cincinnati Conference two papers were presented. These were: "The Application of Enclosed Gearing in the Pulp and Paper Industry," by F. Richardz of the Westinghouse Corporation, and "Air Removal from Stock Ahead of the Head Box," by J. A. Smith of the Rotareaed Corporation.

On Tuesday afternoon a round-table discussion was held on "Thoughts on Standardization," a paper presented by G. E. Clink of the Sandy Hill Iron and Brass Works. All papers have been or will be published in *Tappi*.

A luncheon was held for the members of the Engineering Research and Machine Design Committee on Monday, October 2 during which time the final plans for the meeting were discussed. John Lyall, Chairman of the committee, then discussed the future program enumerating items which had been suggested as possible projects. These projects were then put to vote and the most popular ones selected. Committees were selected to work up the programs for these various projects. The subjects selected and the subcommittee members are as follows:

I. Centralized Control of Stock Systems: Lawrence A. Moore, American Coating Mills, Elkhart, Ind., *Chairman;* Robert C. Berger, General Electric Co., 4966 Woodland Ave., Cleveland, Ohio; and Edwin V.

Ware, Jr., Marathon Corp., Sheridan Road, Menominee, Mich.

II. Methods for Quickly Estimating Costs of Engineering Projects: Harold Ingraham, Chas. T. Main, Inc., 80 Federal St., Boston, Mass., *Chairman;* Lloyd Ewing, Ewing Engineering Co., 5141 North 35th St., Milwaukee, Wis.; Burleigh M. Hutchins, Rust Engineering Co., 1000 Clark Bldg., Pittsburgh, Pa.; and Elmer C. Macklem, Beloit Iron Works, Inc., Beloit, Wis.

III. Correlation of Various Types of Plastometers: Ernest A. Crawford, 231 Walthery Ave., Ridgewood, N. J., *Chairman;* Kenneth W. Brenner, 97 Belemeade Road, Rochester 17, N. Y.; and Philip J. Goldsmith, Pusey and Jones Corp., Wilmington, Del.

IV. Standardization in the Paper Industry: George E. Clink, Sandy Hill Iron & Brass Works, Hudson Falls, N. Y., *Chairman.*

Mr. Clink has agreed to head the last committee but will need assistance in the work. Anyone interested in contributing or assisting Mr. Clink or any of the other chairmen of the subcommittees please contact them. The success of any committee depends on the support of the members of the committee so your cooperation in bettering your own committee and subcommittee is earnestly requested.

Subcommittee chairmen are requested to have the following information to present at the luncheon meeting in February at the annual TAPPI convention in New York.

1. A suggested title for the project
2. The object of the project
3. The scope of the project
4. An outline of the investigation which is proposed
5. A possible schedule of the work to be done

The luncheon meeting will be held on Monday, February 19, at 12:00 noon at the Commodore Hotel in New York City. The room to be used will be posted on the bulletin board. Postcards will be circulated among the members prior to the meeting to determine the attendance.

The committee as yet does not have any papers or proposed papers to be presented at the Fall, 1951 meeting of the Engineering Conferences. While this meeting is some time off it is important that the program be jelled as soon as possible to permit publication of the papers prior to the meeting. Any suggestions you might have as to possible papers or sources of papers would be appreciated. These suggestions should be forwarded to Mr. Lyall or to me. Mr. Lyall's address is c/o Armstrong Cork Company, Lancaster, Pa.

The 1951 TAPPI Engineering Conference is scheduled for the General Oglethorpe Hotel in Savannah, Ga., on October 15–18, inclusive. All advance reports indicate that this will be a very well-planned affair commensurate with the usual efforts of those who plan the Engineering Conferences. Make your plans to encompass this meeting as it will be well worth while.

R. T. De Pan, *Secretary*
Engineering Research and Machine Design Committee

Chemical Engineering Committee

The activities of the Digester Corrosion Committee which is a subcommittee of the Chemical Engineering Committee supplied a basis for considerable discussion at the Cincinnati Engineering Conference. At the Committee Session, Wednesday, October 4, the plans of this corrosion committee were briefly discussed by J. R. Lientz, Chairman. A comprehensive questionnaire has been submitted to all kraft and soda pulp mills in the United States and Canada. The information obtained is expected to serve as a basis for further committee studies. Following a study of the data, it is proposed to have a joint meeting with the committee and an advisory group consisting of representatives of digester manufacturers, steel manufacturers, and insurance companies to utilize the knowledge and experience of this group.

The TAPPI Digester Corrosion Committee is cooperating with similar groups of the Canadian Pulp and Paper Association and the Swedish Technical Association in order to have as much information as possible available. The CPPA is now considering an industry-wide project to be conducted by the Pulp and Paper Institute of Canada to study digester corrosion in Canada. H. O. Teeple, a member of the TAPPI Corrosion Committee, is also a member of the steering committee selected to direct the planning of this program.

A literature survey has been made covering the general problem of digester corrosion. This is now being expanded and studied.

The general subject of "Digester Corrosion" furnished material for a spirited 3-hour discussion on Wednesday afternoon, October 4. At this meeting it was pointed out that the purpose was to exchange information concerning the experiences of various mills, fabricators, and steel manufacturers, and it was not intended to quote any remarks or to publish the discussions in detail.

It was pointed out by J. R. Lientz that the Union Bag and Paper Corporation Savannah mill was studying the operation of digesters of A-212 carbon steel, A-285 Grade "B" Firebox Steel, Type 316Cb 20% stainless clad steel, 20% inconel clad steel, and carbon brick lining. Some mills have noticed a retarding of corrosion which coincided with the formation of scale, and one mill (Crossett Paper Mills) is experimenting with additives designed to promote scale formation. This same mill is experimenting with Type 347 stainless-steel lining, Type 410 stainless clad steel, 10% inconel clad steel, and extra thick Type A-285 Grade "B" carbon steel manufactured under carefully controlled conditions. One mill has lined an existing digester in the field with inconel strips and the technique employed was discussed in detail. It was pointed out that the Audigage was one of the best instruments available for measuring digester shell thickness but that further investigations of instruments for this purpose should be made by an appropriate TAPPI committee. The entire discussion high-

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ighted the fact that steel digesters installed during the last 5 years are showing generally higher corrosion rates than older steel digesters. Even though alloy clad or lined units may show additional resistance to corrosion, the high first cost has to be carefully considered when such units are purchased.

James R. Lientz, *Chairman*
Chemical Engineering Committee

Digester Corrosion Subcommittee

The following are the minutes of the meeting of the Digester Corrosion Subcommittee of the Chemical Engineering Committee that was held at the Statler Hotel, St. Louis, Mo., on March 30–31, 1950. It is given here to provide a background to the important international effort to combat kraft mill digester corrosion and to report on the progress of this subcommittee since it was organized at the TAPPI Annual Meeting in February, 1950.

Those present at the St. Louis Meeting were:

J. R. Lientz, *Chairman*, Union Bag and Paper Corp., Savannah, Ga.
T. T. Collins, Thilmany Pulp and Paper, Kaukauna, Wis.
O. T. Defieux, Crown Zellerbach Corp., Camas, Wash.
W. J. Shelton, Longview Fibre Co., Longview, Wash.
Nicholas Shoumatoff, West Virginia Pulp and Paper Co., New York, N. Y.
Wayne Smith, Crossett Paper Mills, Crossett, Ark.
H. O. Teeple, International Nickel Co. Inc., New York, N. Y.

The meeting was called to order by J. R. Lientz at 10:00 a.m. on March 30, and he outlined the circumstances leading to this first meeting as follows:

The organization of the subcommittee on Digester Corrosion was a direct result of a meeting arranged by G. W. E. Nicholson, Union Bag and Paper Co., New York, and held during the Annual TAPPI Meeting in New York on Feb. 22, 1950.

The people present at Mr. Nicholson's meeting were as follows:

R. H. Davis, Chicago Bridge and Iron Co.
T. T. Dunn, Union Bag and Paper Corp.
K. O. Elderkin, Crossett Paper Mills
S. L. Henry, Union Bag and Paper Co.
T. G. Johnson, Union Bag and Paper Co.
J. R. Lientz, Union Bag and Paper Co.
R. G. Macdonald, TAPPI
George H. Pringle, Mead Corp.
H. A. Schmitz, A. O. Smith Corp.
H. O. Teeple for F. L. LaQue, International Nickel Co.
J. M. Wilcox, Electric Steel Foundry Co.

In view of the seriousness of digester corrosion on an industry-wide basis, Mr. Nicholson thought a committee might be organized under TAPPI auspices to study this problem.

After considerable discussion it was thought desirable by the people present to take the following action:

1. Organize a subcommittee to the TAPPI Chemical Engineering Committee to study digester corrosion.
2. The subcommittee would confine their present activity to the study of corrosion of digesters by alkaline liquors.
3. The members of the subcommittee would be pulp or paper mill personnel chosen on a geographical basis in the United States. An exception to this arrangement would be a representative from the International Nickel Company who would serve as Secretary to the subcommittee.
4. J. R. Lientz, Union Bag, was chosen as Chairman of the subcommittee, and he was to organize the Digester Corrosion Committee and arrange for its initial meeting.

Having thus placed in the record the history of the formation of this subcommittee, Mr. Lientz continued his comments by indicating that the problem of alkaline digester corrosion appeared to be too large and complicated for individual solution. As an illustration of this point, each of the committee members present gave a résumé of individual observations to date on digester corrosion as experienced in the respective mills.

As a result of this discussion, it was apparent that industry cooperation should be solicited. This would include not only the pulp and paper industry but also the allied industries, such as digester fabricators as well as the metal or alloy-producing companies.

After considering ways and means of obtaining this cooperation, the following program was adapted as one most likely to lead to a solution of the problem.

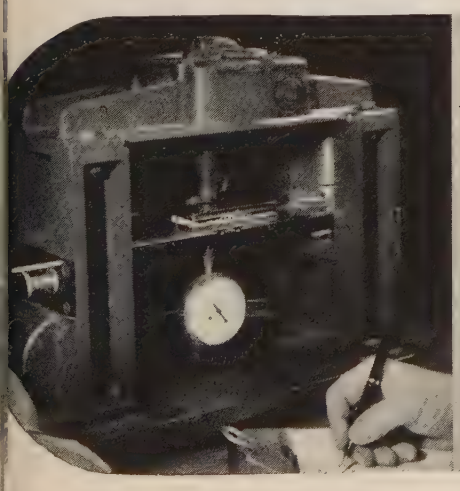
A. Prepare a questionnaire to be sent to all kraft and soda mills.

1. Three copies would be sent to the individual mills, two of which would be file copies and one would be returned to the committee.
2. The questionnaire would be sent to head offices of multiplate companies.
3. The purposes of the questionnaire would be outlined in a covering letter.
4. As far as it was possible, the questionnaire would be sent to top mill management.
5. The completed questionnaires would be returned to TAPPI, who would forward them to the subcommittee.
6. From time to time a progress report would be submitted to the participating mills.

B. Since a committee similar to this one has been established in Canada under the auspices of CPPA, it was deemed advisable to cooperate with the Canadian Committee to the fullest extent.

C. In soliciting cooperation from allied industries, it was thought that at a later date a questionnaire could be sent to fabricators and the same one or another to metal suppliers regarding their respective experiences.

D. It was suggested that cooperation with N.A.C.E. through its Inter-Society Committee might be desirable. This point was agreed upon but this action was to be deferred at present.



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7. **Bleaching of Wood Pulps**
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E. It was agreed that a literature survey be conducted.

F. On the matter of exposing corrosion test specimens in digesters, it was agreed that this would be desirable but for the present, at least, this work could be deferred.

G. The desirability of a standardized method of digester wall thickness testing was thought to be obvious. This matter would be brought to the attention of TAPPI Committee on Standards.

At this point, 7:00 p.m., the meeting was declared adjourned by J. R. Lientz until 9:00 a.m., March 31, 1950.

At 9:00 a.m., on March 31, J. R. Lientz, called the meeting to order. The business was continued from the point of adjournment on March 30.

H. Further discussion resulted in the conclusion that other subject matter relative to alkaline digester corrosion was worthy of consideration.

1. Metallurgical Factors
   a. Carbon steel used past and present
   b. Alloys
      (1) Linings, shop applied and field applied
      (2) Cladding
      (3) Spraying
      (4) Welding overlays
   c. carbon brick
   d. Plastic
   e. Cathodic protection
   f. Plating
   g. Induced scaling
   h. Inhibitors
2. Chemical Factors
   a. Cooking and blow liquor, analysis and preparation of
   b. Types of woods used
   c. Effect of local water supply
   d. Type of recovery system and chemical make-up, emphasis on point of sulphur addition
   e. Composition of relief gases
   f. Type of pulp produced, yield and hardness
   g. Methods of barking and washing of wood
3. Physical Factors
   a. Steam addition and methods of
   b. Method of liquor circulation
   c. Method of chip and liquor additions
   d. Temperature and pressure used
   e. Quenching between cooks
   f. Type, size, and shape of digester
   g. Detail of cooking cycle and controls used

At this point it was decided to draw up a tentative questionnaire which would be circulated to committee members for subsequent comment and revision. The questionnaire is as follows:

1. Name of mill
2. Location of mill
3. Type of cook (check which one)
   Kraft Soda Modified soda Others
4. Data on digesters—tabulate on separate sheet attached
5. Describe corrosion experience of this mill in detail covering such points as follows:
   a. Wear pattern
   b. (a) above in relation to steam nozzles, liquor, and chip charging
   c. Does scale form in digester and what is the pattern of formation and analysis?
   d. Is corrosion rate constant or has it accelerated? Data concerning this would be extremely valuable.
   e. What preventative measures have been taken and what if any were the results obtained?
   f. Have corrosion test specimens been exposed in your digesters and what were the results of these tests?
6. What inspection schedule and procedures have been followed by mill or digester insuring company?
7. Tabulate and describe cooking procedure cover to cover. Include time to pressure, time at pressure, maximum pressure, pressure at blow, blow time, method of adding chips and liquor, automatic control temperature gas off procedure, etc.
8. Has cooking procedure varied during life of digester, if so, elaborate.
9. Give typical analyses of liquors used in cooking operation, both white and black.
10. Give typical analysis of blow liquor.
11. What is source of make-up water for liquormaking system, e.g., evaporator condensate, raw water, filtered water, settled water, etc.?
12. What scaling, if any, is experienced in pulp mill, particularly in evaporators, liquor lines, indirect heaters, etc.? Also what is analysis of scale?
13. What recovery systems have been used and are presently used? What major changes have been made during life of digesters, giving dates, for example, spray-type furnaces.
14. What type and quantity of chemical make-up were used and what major changes occurred during the lives of digesters, for example, use of niter cake, glaubers salt, synthetic salt cake, soda ash and gypsum, elemental sulphur, type of lime, etc.
15. How has sulphidity varied during the lives of the digesters?
16. Analysis of digester relief gases, if available.
17. Type of barking used (a) hand peeling (b) dry drum (c) wet drum (d) hydraulic
18. What special precautions are used to remove sand, dirt, etc. from wood?

J. R. Lientz volunteered to draw up, in typewritten form, the questionnaire prior to review by the committee. It was suggested after the final form of the questionnaire had been approved that it be sent to those companies represented on the committee as test cases to find out if further modifications are indicated.

Since considerable work had already been undertaken by the committee, it was believed unnecessary to hold another committee meeting until Fall. It was suggested the committee meet in Cincinnati during the Annual Engineering Conference of TAPPI.

Since the purpose of the initial meeting of the Committee on Alkaline Digester Corrosion had been fulfilled, the meeting was declared adjourned at 2:30 p.m. on March 31, 1950, by J. R. Lientz, Chairman.

H. O. TEEPLE, *Secretary*
Digester Corrosion Subcommittee

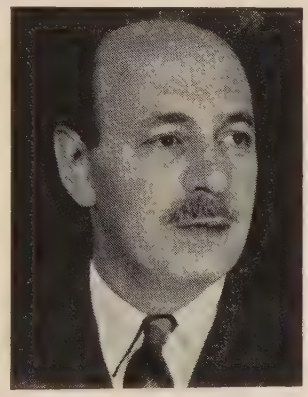
REPORTS AND DISCUSSIONS

Presented at National and Regional Conferences

Fibrous Agricultural Residues Meeting

The TAPPI fall meeting on fibrous agricultural residues, held at the Northern Regional Research Laboratory, Peoria, Ill., November 13–14, brought out an enthusiastic attendance of 70 mill men, chemists, engineers, and equipment manufacturers.

R. T. Milner



S. I. Aronovsky

The papers and talks presented covered a wide range of interest to the strawboard industry, and a feature of the program was the brevity of the papers which afforded active participation of members for questions and thorough discussion.

Eight papers and a round-table discussion comprised the first day's technical program. After the usual self-introductions, R. T. Milner, director of the Northern Laboratory, welcomed the group and described briefly some of the major research projects.

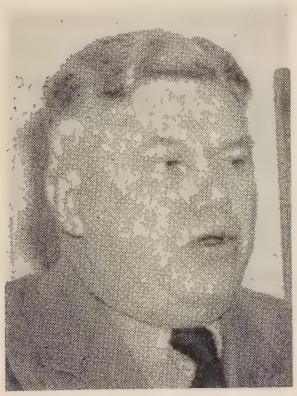
Starting off the technical session, Ralph J. Anderson of Sisalkraft gave the results of his company's experiments, starting as far back as 1937, with Sisalkraft for straw stack coverings. The cover material consists of two layers of 30-pound treated kraft paper reinforced with closely spaced, crossed sisal fibers, and is bonded together with asphalt under heat and pressure. For covering large ricks of baled straw, he said his company had made and tried Sisalkraft blankets up to 26 feet wide. The speaker recommended that before applying the cover, a small overhang or "eave" should be made at the top edge to prevent drip on the sides of the lower tiers. This is done by a slight shifting outward of the top tier of bales. The next step is making a crown by spreading a layer of loose straw over the top, a strict precaution being to pack enough straw in the middle to prevent troughs formed by settling. It was recommended that the paper strips run lengthwise of the rick.

The discussion on "Why cut straw?" was led by M. L. Rankin of Taylor, Stiles and Co. who said that cutting was cheaper than grinding. He listed the following advantages of cutting straw prior to cooking: digesters can be completely charged at one filling; less time is consumed in emptying the digester if straw is precut; cooking is more uniform; necessity for large breaker beaters or other devices to chop and defiber the cooked straw is largely eliminated; and time and labor per ton of pulp are reduced considerably. The speaker also showed how stock handling is simplified by the method, and more uniform pulp and paper result from precut straw.

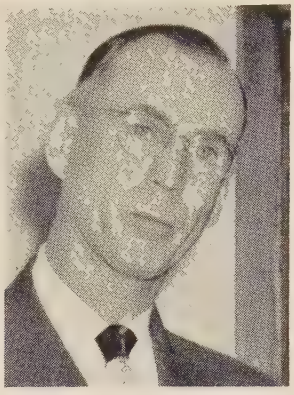
William H. Palm of Hinde and Dauch Paper Co. of Canada next described the layout of his company's mill at Trenton, Ont. The straw is prechopped with a Taylor-Stiles straw cutter and bale breaker. The problem of the moment is the lack of an efficient method for taking the chopped straw away from the unit as fast as it is cut. The cooked straw from 10 rotaries falls onto an inclined floor leading to a canal which runs the full length of the digester building. From the canal

Group attending the TAPPI Fibrous Agricultural Residues Committee meeting held at the Northern Regional Research Laboratory, Peoria, Ill., Nov. 13–14, 1950.

the straw is hosed to a 9000-pound Tugboat equipped with washer drums. The stock from the Tugboat is bled off continuously to the refining system where it is mixed with paper stock. The corrugating paper is made on a 120-inch paper machine.



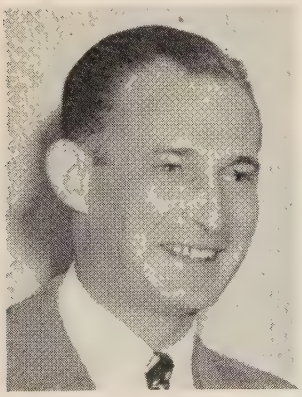
R. J. Anderson



M. L. Rankin

The problems of handling liquid caustic soda were discussed by R. A. Springer of Diamond Alkali Co. He presented diagrams showing schematic plant layouts, placing particular emphasis on the facilities required for dilution of the liquid caustic, especially the 73% solution. Proper types of equipment and practices of storage, insulation, and application of antifreeze measures were recommended.

The development of the Jonsson screen for paper stock was described by Sven Fahlgren of Bird Machine Co. A recent use for this screen, he said, is for knotting kraft pulp ahead of the brown stock washers with advantages of better black liquor recovery and maintenance of a high vacuum on the washers. The speaker also discussed the efficiency of the Jonsson screen for cleaning waste paper and deinked stocks. The Bird vibrating rotary screen also came in for attention as applicable to certain problems in straw processing.



R. A. Springer

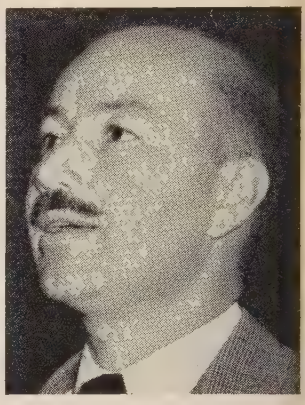
Sven Fahlgren

Two papers on refining were presented. L. E. Eberhardt of Bauer Bros. Co. gave a preliminary report on disk refining of strawboard pulp. Experimental pulp made at the Northern Laboratory by mechanochemical soda cooks was refined in commercial disk mills at the Springfield, Ohio, Fiber Products Laboratory. Acceptable pulps for corrugating were made on both single and double-disk mills at high tonnage rates and relatively low horsepower-input per ton. The double disk mill proved more efficient than the single disk in reducing straw pulp to acceptable material in a one-pass operation.

A report on the operation of the Turbo pulp refiner was made by Lester F. Herman, Gruendler Crusher and Pulverizer Co., who presented data on an experimental mechanochemical straw pulp for corrugating, and on wood pulp. It was shown that stock hydrates to a high degree with a relatively low reduction of freeness. Classification studies of the refined pulp show a minimum, both of extremely coarse as well as of extremely fine material. Also, there was relatively little reduction in fiber length of pulp treated in the Turbo refiner.

In the final paper of the technical program, C. G. Krancher of Ball Brothers Co., Noblesville, Ind., discussed the operation of the Hydracline in cleaning up strawboard pulp. In a 3-week period the removal of rejects averaged about $1^1/_4$ pounds per ton of pulp. More important, however, the use of this cleaning unit results in the manufacture of cleaner paper with fewer breaks in the press section of the paper machine, in greater production, in better felt life, and in lower maintenance costs on rubber press rolls.

L. E. Eberhardt



L. W. Hesse

As usual, the annual dinner was held during the evening of the first day. It was preceded late in the afternoon by a tour of the Pabst Brewing Co.'s Peoria plant, and followed by a social hour and banquet at Pabst hall. At the dinner, S. I. Aronovsky, Chairman of the Fibrous Agricultural Residues Committee of TAPPI, introduced R. G. Macdonald, Secretary-Treasurer of TAPPI who spoke on the TAPPI activities of the entire paper industry. R. T. Milner, director of the Northern Laboratory, introduced L. W. Hesse, community relations director of the Keystone Steel and Wire Co., Bartonville, Ill., whose subject was "What is Today's Steel Situation?"

The second day's sessions covered reports on committee activities, the results of cooperative experiments on straw preservation, and demonstrations of testing equipment. Ralph E. Green, Thwing-Albert Instrument Co., demonstrated his company's latest model laboratory corrugator, producing in a few minutes single-face and double-face board samples suitable for test'ng. W. J. Delmhorst, Delmhorst Instrument

Speakers' table at the Annual Dinner of the TAPPI Fibrous Agricultural Residues Committee. Left to right: J. H. Ritter, E. C. Lathrop, L. W. Hesse, S. I. Aronovsky, R. G. Macdonald, and R. T. Milner.

C. G. Krancher

L. F. Herman

Co., displayed his improved portable apparatus for estimating moisture in baled straw.

Plans for 1951 were discussed. A meeting of the committee will be held at the Annual TAPPI Meeting in New York, Feb. 19 to 22, 1951. The group decided that the major session of the 1951 fall meeting should be a round-table discussion based on a questionnaire to be circulated among the strawboard mills. The site of the 1951 meeting was not definitely decided, but very likely it will be in the vicinity of a strawboard mill.

The 1950 meeting ended with two tours, one of the Northern Laboratory and the other of the plants of the Keystone Steel and Wire Co.

This year's fall meeting was the fourth held at the Northern Laboratory since 1944 when the Fibrous Agricultural Residues Committee was organized. The papers presented were quite interesting, and practically everyone present joined in the frank and lively discussions. The entire Laboratory staff, especially Director Milner, E. C. Lathrop, head of the Laboratory's Agricultural Residues Division, and Committee Chairman S. I. Aronovsky, in charge of the division's pulp and paper section, assisted in every possible way with the Laboratory's facilities to make the meeting successful.

RECENT BOOKS

Physical Chemistry of High Polymeric Systems. 2nd Ed. By H. Mark, Polytechnic Institute of Brooklyn, and A. V. Tobolsky, Princeton University, 1950. New York. Interscience Publishers, Inc. Cloth, 6 × 9, 506 pages. $6.50.

This is Vol. II in the High Polymer Series of Interscience Publishers, Inc. It has been completely revised and augmented by an additional 150 pages, 56 figures and 13 tables. As in the 1st edition its subjects include: geometry of molecules as revealed by diffraction methods, behavior of molecules in electric and magnetic fields, molecular spectra, valences, crystal structure and forces, mechanical behavior, chain reaction, polymerization, and degradation of high polymers.

Anyone who has heard the lectures of Dr. Mark at various TAPPI meetings can appreciate the clearness with which he produces a clear understanding of a very complex subject such as this. Although it is necessary to include considerable theory and mathematics in such a learned text it also presents a running story that can be understood by those who may not wish to delve in the interpretations of the various phenomena described.

Procurement-Principles and Cases. By Howard T. Lewis. Professor of Marketing, Harvard University, Chicago, 1949. Richard D. Irwin Co. Cloth, 6 × 9, 476 pages. $6.00.

Although this review is a little late the book came to the reviewers attention only recently and since it was written by the author of the very successful "Industrial Purchasing," a book sponsored by the National Association of Purchasing Agents it was deemed important to draw attention as we again approach days of materials expediting.

It includes such subjects as: organization, procedure, quality determination, inspection, inventory control, disposition of waste material, assurance of supply, source selection, major equipment, price policies, legal aspects, etc. A feature of the book is the inclusion of actual case studies to illustrate each subject.

Torchbearers of Chemistry. By Henry Monmouth Smith, formerly Professor of Inorganic Chemistry, Mass. Inst. of Technology. New York. Academic Press, Inc. 1950. Cloth, 7 × 10, 270 pages. $6.00.

This book is composed of portraits and brief biographies of scientists who have contributed to the making of modern chemistry. It is an outgrowth of a financial gift by Mr. F. J. Moore to M.I.T. to be used to promote an appreciation of the cultural value of chemistry. The unusual collection of 263 photograph portraits of chemists who should be better known although the results of their works are part of todays knowledge is a feature that should appeal to every student of chemistry.

Motor Oils and Engine Lubrication. By Carl W. Georgi, Technical Director, Quaker State Oil Refining Co. 1950. New York. Reinhold Publishing Co. Cloth, 6 × 9, 513 pages. $8.50.

This book deals with the practical problems of engine usage, maintenance and lubrication, as well as causes and remedies affecting operating troubles. It avoids, as much as possible, involved technical considerations.

It covers such subjects as chemical and physical properties, service behavior, performance characteristics, motor oil additives, engine lubrication, engine sludge deposits, oil contamination, engine wear, bearings and valves, oil systems and filters, diesel engines, A.S.T.M. and S.A.E. specifications.

Paper Base Laminates. By S. E. Sorrell, formerly Chief Chemist, Samuel Jones & Co. Ltd. Cleaver-Hume Press Ltd. London. Distributed by Interscience Publishers, Inc. New York. 1950. Cloth $4^3/_4 \times 7^1/_2$, 223 pages. $2.75.

This is a monograph written by an English author and it therefore refers to papers such as esparto as well as the other well-known kinds. It is a concise account of the manufacture, characteristics, testing, and use of laminates composed of resins reinforced with paper sheets.

The chapter subjects include: The paper base, the resin binder, paper treatment, laminating procedures, laminates for special purposes, fabrication of laminates, physical testing of paper-base laminates, factors affecting the physical properties, and the application of paper-base laminates. It is well illustrated and contains photomicrographs furnished by PATRA.

Copies of all books reviewed in this issue may be obtained from the Book Dept., *Tappi*, 122 E. 42nd Street, New York 17, N. Y.

Slime Acclimatization

PAUL A. SARTORETTO

THE slime preventatives in widespread use belong to either the organic mercurial or chlorinated phenol types. Phenyl mercuric acetate and pentachlorophenol are the most popular examples of each of these two types. Although phenyl mercuric acetate is approximately 15 times more expensive than pentachlorophenol, the cost factor is balanced by the high bacteriostatic and fungistatic efficiency of the mercurial. Appling has reported that 1 p.p.m. of phenyl mercuric acetate will inhibit *Aerobacter aerogenes* and *Aspergillus niger*. The former is the most prevalent organism in paper mill slime, and the latter is also a common fungus type encountered in paper mill systems.

There are some mill systems which have operated for years with either type of slimicide and have used these interchangeably without appreciable cost advantage. A few mills report encountering a phenomenon of slime acclimatization necessitating shock treatments of suddenly reversing back and forth from mercurials to chlorinated phenols in order to control organisms which have become resistant either to one treatment or another.

It has been found that the majority of the mills have obtained favorable slime control with mercurials exclusively. However, as a result of investigating complaints in a few mills using large amounts of mercurials without satisfactory control, mixed slime cultures have been obtained which demonstrate unusual resistance to all types of mercurials. These same mixed organisms are also slightly more resistant to the usual chlorinated phenol dosage.

The penicillin cup plate method appears the best bacteriological test to offer visual representation of this phenomenon.

The mixed slime taken from slime boards was cultured and subcultured for 3 successive days to obtain high virulency. One milliliter of slime culture medium was mixed with 30 ml. of sterile warm liquid nutrient agar medium in a Petri plate and the mixture was allowed to harden. Porcelain cylinders with one edge beveled were sunk into the agar to a depth at which the beveled edge was submerged; 0.15 milliliter of a known dilution of slimicide was pipetted into the cylinder, and the plates were incubated at 37°C. for 48 hours before readings were taken. Slow diffusion of the slimicide into agar occurs with the formation of a ring or a clear zone of inhibition around the porcelain cylinder. The slimicide with the largest zone is most effective.

The results of a typical study can be summarized as follows: one sample was found to be susceptible to both mercurials and chlorinated phenols and bore a close relationship to *Aerobacter aerogenes*. The addition of small quantities of chlorinated phenols to mercurials had no value in inhibiting its growth of *Aerobacter aerogenes*. Another slime was resistant to mercurials but susceptible to them in the presence of small quantities of chlorinated phenols.

Regarding the accuracy of these tests, it was demonstrated that an increase in concentration is not always accompanied by a corresponding increase in zone inhibition. It is doubtful that the accuracy is better than 20% plus or minus.

Continuing the study with second sample of slime using a modified FDA 198 method for determining the effect of germicidal dilutions of phenyl mercuric acetate and various chlorinated phenols and mixtures thereof, results were obtained that were somewhat consistent with the penicillin cup plate method.

The following procedure was used: 10 milliliters of each slimicide dilution were inoculated with a 1 milliliter 24-hour broth culture of the slime. After 60 minutes had elapsed, a loopful from each dilution tube was transferred to a Petri plate containing sterile nutrient agar. The plates were incubated at 37°C. for 24 hours. The results represent the dilution necessary to produce 100% kill of the slime in 1 hour.

From the results of these tests (Table I): (1) It can be concluded that phenol coefficients or inhibition concentrations derived from tests with pure organisms are not always reliable for evaluating slimicides. (2) Mixed slime samples vary from mill to mill and it is possible that occasionally slime acclimatization will be encountered which calls for special treatment. (3) Mixed slime taken from the paper mill affords better samples for evaluation. (4) Our bacteriological results indicate that very small percentages of chlorinated phenols will as a rule enhance the germicidal and bacteriostatic activity of mercurials, but this is not always true. The proper treatment during slime acclimatization periods is not necessarily shock treatment of mercurial and chlorinated phenol on alternate weeks or months but probably simultaneous treatment. (5) Slug treatment involving germicidal dosages of mercurials should be more effective in certain instances with low concentrations of chlorinated phenols.

In view of chlorinated phenol odor problems encountered in some mills, it is encouraging to note that the chlorinated phenol concentrations in combination with phenyl mercuric acetate are extremely low. Furthermore, pentachlorophenol, the least odorous, is just as effective as the other chlorinated phenols, contrary to phenol coefficient values determined by the manufacturer.

A final word of warning regarding compatibility of mercurials and chlorinated phenols; mercurials are cationic germicides whereas chlorinated phenols are anionic. They will coprecipitate forming mercurial salts of the chlorinated phenols up to a certain dilution. For example, phenyl mercuric acetate and pentachlorophenol will form insoluble phenyl mercuric pentachlorophenate at dilutions of 100 p.p.m. at a pH

PAUL A. SARTORETTO, W. A. Cleary Corp., New Brunswick, N. J.

Table I. Germicide Dilution Necessary to Produce 100% Kill of Slime in 1 Hour

Phenyl mercuric acetate, p.p.m.	*Pentachlorophenate (4), p.p.m.*	*o-Phenylphenate (25), p.p.m.*	*2,4,5-Trichlorophenate (30), p.p.m.*	*Chloro-2-phenylphenate (120), p.p.m.*
100 −	2000 −	10,000 ++	10,000 −	10,000 ++
50 +	1000 −	5,000 ++	5,000 +	5,000 ++
20 ++	500 +		2,000 ++	
20	40 −			
10	20 −			
1	2 +++			
20		40 −		
10		20 +++		
1		2 +++		
10			20 −	
1			10 +++	
20				40 −
10				20 +

Growth of slime. − indicates no growth; ++ moderate growth; + light growth; and +++ heavy growth.

7.5 or below. Above a pH 9 the two are barely compatible at 1000 p.p.m. It is therefore recommended that additional alkali should be added over and above the amount necessary to form the soluble sodium or potassium salt of chlorinated phenol in order to increase compatibility. Also make sure that the points of addition are such that when they meet in the mill stream, they are properly diluted. Or if the point of addition for each is the same, make sure that timing of addition will insure proper dilution.

Presented at the Annual Meeting of the Technical Association of the Pulp & Paper Industry, New York, N. Y., Feb. 20–23, 1950.

Steam Improvement—Settling Pulp and Paper Mill Waste Waters and Dewatering Bulk Solids

AUGUST S. ERSPAMER and WILLIAM D. RICE

THIS paper describes the steps taken by a pulp and paper mill toward the solution of its waste disposal problem. These include reduction to a minimum of wastes inside the mill by good housekeeping and improvements in equipment and operations. Pilot plant studies were carried out to obtain information on sedimentation and sludge handling which could be applied to a process for treating the wastes requiring outside treatment. Plain settling was found to effect a reduction of 63% in turbidity, 86% in suspended solids, and up to 98% in settleable solids at an optimum detention time of two hours. A 15% B.O.D. removal was observed while pH and color remained practically unchanged. The addition of chemicals in reasonable quantities did not significantly affect the results of plain sedimentation. Sludges from plain settling could be dewatered on an experimental rotary vacuum filter to give a handleable cake with loadings in the range of 1.2 to 5.2 pounds per square foot per hour.

The P. H. Glatfelter mill, located in Spring Grove, Pa., on the west branch of Codorus Creek, is a semi-integrated mill manufacturing book, bond, and other grades of fine papers. The present capacity is 180 tons of finished paper per day as compared to 1500 pounds daily when the mill was founded in 1864. In order to attain the current productive capacity, the mill has undergone a number of successive modernization and expansion programs, the latest of which is nearing completion. The major departments of the mill are the steam and power plant, pulp mill, bleach plant, deinking plant, and paper mill. The pulp mill produces unbleached pulp, cooking pine and local hardwoods by the soda process. This pulp is bleached to a high white color in the bleach plant by a four-stage bleaching process. In the deinking plant waste papers are treated to remove the ink and then bleached to give a pulp suitable for white papers. The bleached pulps from the bleach plant and deinking system as well as purchased bleached pulps are used in the paper machine department along with fillers, rosin, dyes, and papermaker's alum to produce the various types of high-grade papers.

The mill main effluent wastes include the chlorination and caustic extraction stage washer filtrates in the bleach plant, deinking washer discharge, paper machine losses, and wash-ups. Some of the wastes from the pulp mill, the lime sludge in excess of lime kiln capacity and carbon, a byproduct of the soda recovery process, are pumped to sludge basins where the carbon and lime sludge are allowed to settle and the effluent then released to the creek. The domestic sewage of the mill is separated from the process wastes and diverted into the public sewer system of the borough of Spring Grove. The pollutional effects of an industrial waste on a stream, aside from appearance, are due to bulk solids which settle out and cause deposits in the stream, suspended matter, and soluble materials. Substances present in the pulp and paper mill wastes include fiber, fillers, soluble oxidizable materials, salts, pulp-processing rejects such as knots, screening rejects, carbon, lime sludge, spent cooking, deinking, and bleaching liquors.

A. S. ERSPAMER, Technical Director, and W. D. RICE, Chemical Engineer, P. H. Glatfelter Co., Spring Grove, Pa.

INSIDE TREATMENT

The company has always had an interest in stream improvement, not only from the standpoint of reclaiming raw materials, an economic necessity, but also because of the desire to improve the stream as a public service and as a means of building good will. Much of the required treatment can be accomplished in the mill itself. Moreover, the most effective and usually the least expensive methods of waste disposal are preventive and corrective measures applied at the source. Any reduction of solids discharged to the creek effected by careful and improved mill operation results in a direct benefit to the stream. This may be termed inside treatment. Realizing this, the P. H. Glatfelter Co. has constantly kept on the alert in regard to improved means of minimizing losses to the sewer.

At an early date the company instituted a program for the development of paper-machine white-water systems which would be "closed" as much as possible. The program included paper-machine flow and white-water surveys to determine existing losses and the extent to which their prevention was feasible. Furthermore, such surveys were conducted so that the results of improvements could be evaluated. Reduction in the use of fresh water to a minimum was essential not only in order to economize on water usage but also to simplify the reuse of white water. The increased recirculation and reuse of white water on the paper machines was the next logical step. The white-water systems of the various paper machines were redesigned thus permitting the use of more white water and resulting in considerable reduction in the amount of white water discharged from the paper machines. In conjunction with white water utilization, the company installed the latest and most efficient saveall equipment available to remove fiber and filler from the excess white water. The excess white water discharged from the paper machines was collected in large tanks and used in place of fresh water for washing pulps in the bleach plant. In this way a considerable amount of white water was reused, fresh water conserved, and the contribution to stream pollution thereby reduced.

These efforts, although extensive, were intensified when the company was notified by the Sanitary Water Board of the State of Pennsylvania to submit to the board for approval a report including detailed construction plans for works to provide treatment for the waste waters "to effect a reduction

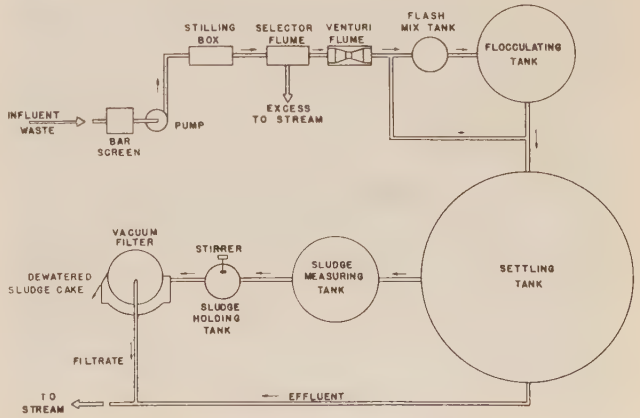


Fig. 1. Schematic diagram—waste-treatment pilot plant

in their pollutional characteristics equivalent to the complete treatment of municipal sewage." As a part of the program to comply with the board's directive, consulting engineers were engaged and the stream improvement program was carried out cooperatively. To justify an installation of a treatment works, which is certain to require a large capital outlay, there must be assurance that the proposed installation will function effectively and produce results commensurate with expenditure and the requirements of the Sanitary Water Board of the State of Pennsylvania. Neither the interests of the public, the Sanitary Water Board, nor the company would be served by the premature construction of treatment facilities without full and careful consideration of all the factors involved.

There is, at present, no recognized and standardized method for the treatment of wastes from a semi-integrated pulp and paper mill. The solution of the problem must be realized through progressive stages. The first point of attack is to determine the characteristics of the wastes which may be expected from day to day. There will always be some variations, but it is important that these variations be evened out as far as practicable so that the volume and composition of the wastes to be treated may be determined within reasonable limits. Until such time as improvements in mill operation and control are fully effective and a composite waste of predictable characteristics is established as routine, experimental work on a pilot-plant scale was not fully warranted.

The technical department carried out extensive surveys and made detailed flowsheets of the entire mill showing the place of occurrence, volume, and type of water used. Plans were worked out to further reduce the usage of fresh water by making changes in operations and more use of white water. Efforts were also concentrated on the elimination of leaks, unnecessary usage and waste of fresh and white water, tank overflows, etc. The technical department instituted a program aimed at helping mill-operating personnel reduce waste and, at the same time, educating them to the importance of preventing and eliminating waste. When the mill operations were surveyed, note was made of the various points or operations where it was known or believed that improper conditions might occur. From the survey an extensive list of check points was compiled for daily observation. The listing was grouped or broken down according to the various departments and sections of the mill. Some 200 check points were listed and checked daily insofar as was practicable.

Improper conditions were reported orally to the operators and by written notification to supervisory personnel. Upon oral notification, the operator or foreman checked into the condition and corrected it, if possible. If maintenance attention was necessary, steps were taken to obtain the services required. The second step in reporting of conditions made use of a report form whereby written notification of an improper condition was directed to the mill superintendent with copies to management and the engineering department. Upon written notification, a further check was made by manufacturing supervision to confirm that action toward correction had been taken. If the condition could not be corrected without major repairs or alterations, or if it recurred too frequently for any other reason, the condition was specifically referred to the attention of management for decision as to what action was to be taken.

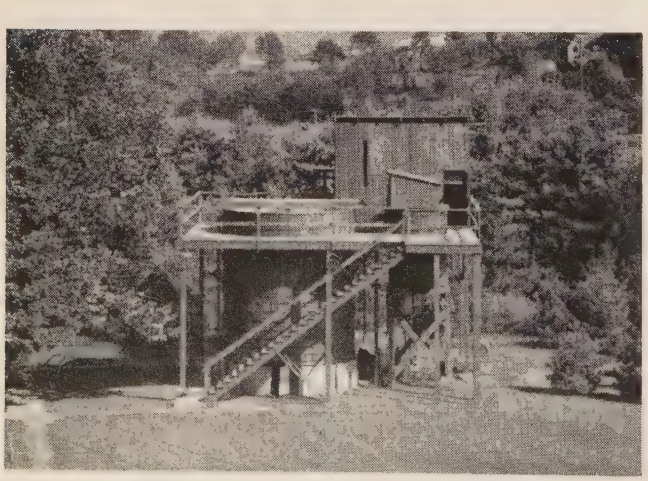


Fig. 2. Waste-treatment pilot plant

Fig. 3. Settling tank—top view

The importance of the program was emphasized to mill personnel by taking hourly samples of the main effluent discharge and displaying them in a prominent part of the mill. This sampling was carried on as one of the duties of the paper-quality control testers. In the event any excessive amount of fiber, filler, or other waste was noted in the sample, the mill superintendent or a person designated by him was notified at once so that the cause could be investigated and the condition corrected. The program is currently being implemented by locating additional stations for the sampling of departmental sewers as an aid to the tracing of sources of excessive stock and other losses. An hourly schedule of sampling at the various locations, with sample racks provided for display of the samples, will be carried out under the supervision of foremen capable of quickly identifying the particular source of waste and acting for immediate correction of the condition.

In order to follow the changes in the waste discharged brought about by more efficient mill operation and improvements, as well as to determine the volume and character of combined wastes which must be treated, more accurate methods of measurement and sampling the waste discharged in the main effluent were utilized. The rectangular weir with manual sampling and visual measurement of flow rate was replaced by a 3-ft. venturi flume equipped with a float-activated unit which electrically transmitted the flow measurement to a recording and integrating flowmeter located in the laboratory. An automatic sampler, which takes a volume of sample in proportion to the flow, was also installed. In a 2-year period, in spite of increased mill output, a reduction was brought about in the volume of waste from $8^1/_4$ million gallons per day to $6^1/_2$ million gallons per day. At the same time a considerable decrease in solids discharged was realized, as well as a stabilization in the character of the waste, a prerequisite to any treatment works.

PILOT PLANT PROGRAM

In spite of mill improvements and reduction of pollutional load by inside treatment, there still remained a large volume of waste which required outside treatment. In order that a

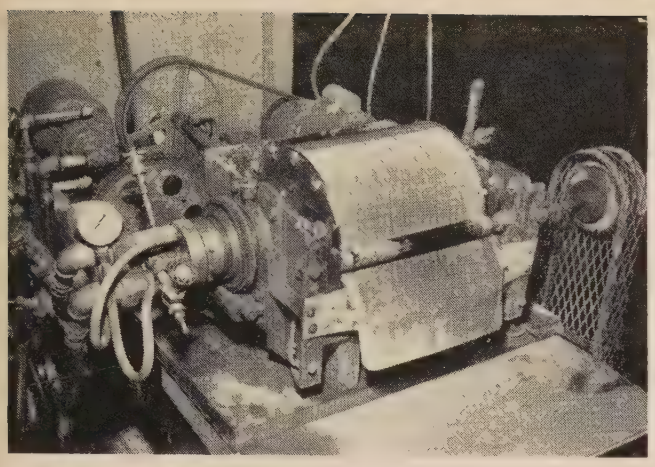


Fig. 4. Experimental rotary vacuum filter

method could be devised to make such treatment most effective and within economic range, a pilot plant (*1*) was constructed and put into operation. The general program layout was developed through the joint efforts of the technical department, the consulting engineers, representatives of management, and the National Council for Stream Improvement. Engineers from the State Sanitary Water Board also contributed valuable suggestions in the course of various meetings.

Description of Pilot Plant

A schematic diagram of the waste-treatment pilot plant is presented in Fig. 1 and the plant is shown in Fig. 2 with the settling tank on the left and the flocculating tank on the right.

The waste from the main effluent channel was pumped to the pilot plant by a 200-g.p.m. centrifugal pump protected by a bar screen. The selector flume, a portion of which served as the stilling box, regulated the rate of flow. The volume of flow was measured by a 3-inch venturi flume and chemicals, when called for, were added at the discharge end of the flume. A 50-gallon closed wooden barrel with a bottom inlet and a side outlet near the top served as the flash mix tank. This was followed by a 6 by 6-foot cylindrical wooden flocculating tank.

The circular settling tank (Fig. 3), a wooden stave tank 14 feet in diameter and $14^3/_4$ feet deep, was fitted with a 45° sloped-cone bottom. The effective settling depth and detention volume were $11^1/_4$ feet and 10,100 gallons, respectively, and a 2-hour detention time was attained at a throughput of 84.5 gallons per minute. The baffle submerged inlet was at the center of the tank and the submerged outlet at the perimeter was equipped with a scum baffle. The tank was provided with decanting pipes to remove the supernatant waste at the end of a run prior to withdrawing the sludge.

The hopper bottom of the settling tank served as a collector for the settled sludge which was drawn off by gravity to the sludge measuring tank. A 1 by 1-foot rotary vacuum filter (Figs. 4 and 5), covered with a 60 by 40 mesh stainless-steel wire cloth, was employed for the sludge dewatering tests. The filter had a total filtering area of 3.14 square feet and was operated at a vacuum of 25 to 27 inches, with 25% submergence.

Procedure

The pilot-plant program was divided into two phases, sedimentation and sludge handling. The sedimentation tests covered both plain settling and settling aided by chemical treatment, using alum and pickling liquor. The test runs were 6, 7, and 9 hours in length for detention times of 1, 2, and 4 hours, respectively. In the plain settling tests, ten repeat runs were carried out under each set of conditions. The chemical coagulation tests were exploratory in nature with only one or two runs being made at each of the test conditions.

Two composites of the influent and effluent wastes, consisting of samples collected every 15 minutes, were made for each run. One influent (or effluent) composite represented the first part of the run and the other composite the last part of the run. The supernatant waste in the settling tank was decanted down to the sludge level at the end of each run and the sludge withdrawn to the sludge measuring tank. The volume of sludge was then recorded and a sample taken for analysis.

Sludges obtained by plain settling were filtered on the rotary-vacuum filter with and without sludge conditioning and/or compaction. The investigation covered (1) the general characteristics and filterability of plain-settled sludges, and (2) effects of sludge conditioning and/or compaction. The chief materials used for sludge conditioning were lime and carbon, the latter derived from the pulp-mill recovery system. A total of 134 filter runs were made on 65 different sludges with approximately 30 gallons of sludge being used for each test. Filtering cycles of two and one-quarter and six minutes were employed and the average length of run was one-half hour. Imhoff cone tests were performed on mixtures of mill-waste and sludge filtrate to determine effects of filtrate addition upon mill-waste settling characteristics.

Analytical Methods

The analyses are covered by the procedures outlined in standard methods (*2*). The B.O.D. determinations were made using standard water seeded by fresh sanitary sewage. Turbidity was determined with a Hellige turbidimeter and pH with a Leeds and Northrup, No. 7662, pH meter.

RESULTS

Plain Sedimentation

Data summarizing the results of plain sedimentation, including the effect of detention time, are presented in Table I. A high reduction in settleable solids volume was effected by plain settling with detention times in the range of 1 to 4 hours exerting only a small effect. The over-all average turbidity removal was 60% and the suspended solids reduction averaged 85%, being 82, 86, and 88% for 1, 2, and 4-hour retention times, respectively. The differences in pH and color of the waste before and after treatment were negligible and the 5-day B.O.D. reduction averaged 15%.

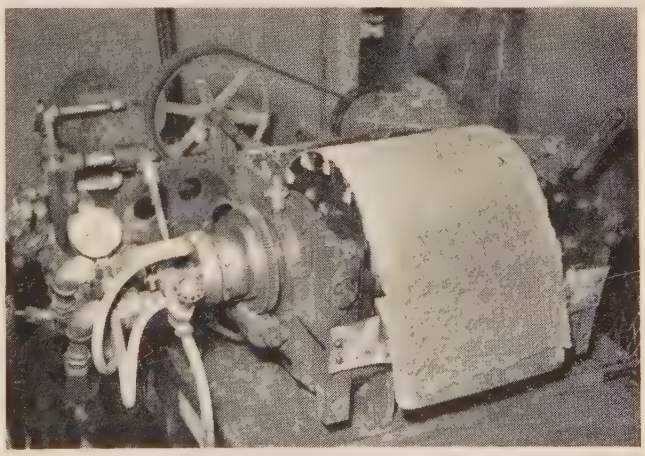


Fig. 5. Vacuum filter in operation

Table I. Plain Sedimentation—Effect of Detention Time

Detention time, hr.	1	2	4
Number of runs	10	10	10
Settleable solids			
Influent, ml./l.	32	30	27
Effluent, ml./l.	1.0	0.7	0.2
Removal, %	97	98	99
Suspended solids			
Influent, p.p.m.	623	744	628
Effluent, p.p.m.	113	99	76
Removal, %	82	86	88
Turbidity			
Influent, p.p.m.	212	266	212
Effluent, p.p.m.	101	96	77
Removal, %	53	63	64
pH			
Influent	7.7	9.0	8.0
Effluent	7.5	8.8	7.8
Color			
Influent, p.p.m.	290	250	270
Effluent, p.p.m.	275	250	260
Removal, %	4	0	3
B.O.D.			
Influent, p.p.m.	164	145	185
Effluent, p.p.m.	139	124	157
Removal, %	16	15	15
Sludge			
Concentration, %	3.7	4.2	3.0
Ash, %	40	44	41
Loss on ignition, %	60	56	59

The sludge obtained had an average concentration of 3.6% and on analysis gave an average of 42% ash and 58% loss on ignition.

Chemical Treatment

The results of chemical flocculation tests are given in Table II. These studies were exploratory in nature and

Table II. Effect of Chemical Addition—Detention Time Constant at Two Hours

Chemical added	*None*	*Alum*	*Alum*	*Pickling liquor*	*Pickling liquor*
Dosage, p.p.m.	0	100	400	100	400
Number of runs	2	1	1	2	2
Settleable solids					
Influent, ml./l.	29	15	24	17	23
Effluent, ml./l.	0.2	0.2	0	0.2	0.1
Removal, %	99	99	100	99	99
Suspended solids					
Influent, p.p.m.	478	173	340	377	478
Effluent, p.p.m.	57	41	47	52	97
Removal, %	89	76	90	85	78
Turbidity					
Influent, p.p.m.	220	80	105	162	275
Effluent, p.p.m.	85	23	30	55	75
Removal, %	61	71	71	65	72
pH					
Influent	7.9	6.0	7.0	7.1	7.7
Effluent	7.9	5.0	4.4	6.6	6.4
Color					
Influent, p.p.m.	100	200	150	200	125
Effluent, p.p.m.	100	180	60	250	215
Removal, %	0	10	60	−25	−55
B.O.D.					
Influent, p.p.m.	178	130	116	174	204
Effluent, p.p.m.	133	100	78	130	145
Removal, %	26	23	33	30	29

indicate that the only significant change brought about by addition of chemicals was a 60% reduction in color when 400 p.p.m. of alum were used. Pickling liquor, on the other hand, tended to increase the color of the effluent from the pilot plant.

Sludge Filtration

Table III shows the results obtained when sludges produced by plain settling were filtered on the experimental rotary vacuum filter. Loadings ranging from 1.2 to 5.2 pounds dry solids per square foot per hour were obtained, dependent largely upon variations in concentration and filtering cycle. It was found that concentration of the sludge had a decided effect upon loadings attained, higher concentrations, in general, resulting in higher loadings. On the average, higher loadings were obtained at the faster (two and one-quarter minute) cycle, but resulting cakes were also wetter and sometimes difficult to remove. Cakes produced at the six-minute cycle were generally drier, thicker, and more readily handleable. Little variation was experienced in sludge composition, hence no particular correlation between this factor and filtering characteristics.

Table III. Experimental Rotary Vacuum Filter Tests Unconditioned Sludges

Sludge				
Concentration				
Range, %	2.0–2.9	3.0–3.9	4.0–4.9	5.0–5.9
Average, %	2.5	3.5	4.4	5.7
Ash, %	40	39	41	45
Loss on ignition, %	60	61	59	55
2¼-Minute filter cycle				
Number of tests	3	15	6	1
Filter cake				
Lb./sq. ft./hr.	2.9	3.2	4.3	5.2
Moisture, %	75	76	78	71
Thickness, in.	2/32	3/32	5/32	6/32
Filtrate, gal./sq. ft./hr.	12.6	9.7	9.8	8.8
6-Minute filter cycle				
Number of tests	8	17	9	1
Filter cake				
Lb./sq. ft./hr.	1.2	1.7	2.3	3.9
Moisture, %	72	72	72	65
Thickness, in.	3/32	4/32	7/32	8/32
Filter cake (composite)				
Ash, %	39	38	41	50
Loss on ignition, %	61	62	59	50
Filtrate (composite)				
Suspended solids, p.p.m.	821	733	901	1530
Vol. susp'd. solids, p.p.m.	394	300	379	733

Results of conditioning studies covering 15 runs indicate that an average increase in net loadings up to 45% was realized through the use of lime (flocculant) or carbon (inert filter aid). Approximately 25% increase in loading was obtained after 24-hour compaction of the sludge. A typical run illustrating effects of conditioning and compaction is shown in Table IV.

Table IV. Sludge Compaction and Conditioning Tests Vacuum Filter Run 57

Compaction	*Sludge concentration, %*	*Conditioner*	*Filter loadings*[a] *Gross*	*Net*	*Cake moisture, %*
None	3.1	None	1.4	1.4	75
24 hours	3.9	None	1.6	1.6	78
None	3.7[b]	Carbon-30%	2.8	2.2	73
None	2.9[b]	Lime-5% CaO	1.8	1.7	70
None	2.8[b]	Lime-10% CaO	2.3	2.0	72

[a] Lb./sq. ft./hr. Net loading = gross less conditioner.
[b] Includes conditioner.

The character of filtrate from the rotary filter was similar to that of the raw mill waste. Imhoff cone tests demonstrated that filtrate addition to raw waste had very little effect upon settling characteristics, changes in amounts of settleable and nonsettleable solids being insignificant.

CONCLUSIONS

The proper disposal of wastes from a pulp and paper mill is a major problem involving both the elimination of wastes inside the plant by good housekeeping and improved methods of mill operation as well as outside treatment of the stabilized wastes discharged.

Pilot plant studies to obtain information on sedimentation which could be applied to a system for outside treatment of the stabilized wastes indicated that plain settling at an optimum detention time of 2 hours effected a reduction of 63% in turbidity, 86% in suspended solids, and 98% in settleable solids volume. The B.O.D. removal was small (15%) while pH and color remained practically unchanged. The results of plain sedimentation are not appreciably improved by the addition of chemicals in reasonable amounts.

The sludge produced by plain sedimentation can be dewatered on a rotary vacuum filter to form a readily handleable cake containing 68 to 75% moisture with a minimum net yield of 2 pounds dry solids per square foot per hour, compaction and use of conditioning agents being necessary, at times. Higher loadings are attainable, dependent chiefly upon the variables of concentration, compaction, optimum drum speed, and conditioning.

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2. "Standard Methods for the Examination of Water and Sewage," Ninth Edition, American Public Health Assoc., 1946.

Presented at the Annual Meeting of the Technical Association of the Pulp and Paper Industry, Hotel Commodore, New York, N. Y., Feb. 21–24, 1949.

Ed. Note: This paper is quite similar to another previously presented at a meeting of the American Chemical Society by the same authors. The reference is (*1*) under Literature Cited.

The writers wish to acknowledge the assistance rendered by the National Council for Stream Improvement in the sedimentation phase of studies, and by Oliver United Filters, Inc., for making available the experimental rotary vacuum filter.

Silicate of Soda Uses in the Paper Mill

F. ROBERT MacGONAGLE

SILICATE OF SODA has long been recognized as a useful chemical by the paper industry and, as such, is widely used for various purposes. There has been such extensive development in the technology of its use during the past ten years that a review of the general subject at this time seems worth while.

In considering the various uses of silicate of soda, it is important to recognize at the outset that "silicate of soda" is a generic term like paper or coal. In order to properly appraise its applications, some conception of the properties of the various available forms of silicate of soda is necessary.

Silicates of soda represent predetermined combinations of sodium oxide and silica in forms which are water soluble or already in solution. By varying the ratio of the soda and silica as well as by manufacturing at different concentrations, certain desired properties can be obtained. While there are over fifty grades of silicate of soda offered to industry, probably the ones most interesting to the paper manufacturer can be listed as follows:

$Na_2O:SiO_2$
1:3.75
1:3.22
1:2.9
1:1.6
1:1—Sodium metasilicate
3:2—Sodium sesquisilicate

It will be noted that the first four ratios, above the line, are colloidal solutions, while the last two are readily soluble crystalline chemical individuals. All silicates in the list have certain properties in common. In the first place, they are all alkaline. They all have some wetting power, emulsifying power, ability to saponify materials, and the ability to disperse finely divided solid particles and hold them in suspension. When reacted with certain other chemicals the silicates decompose, losing their alkalinity, but the products of decomposition are often important and very useful in their application.

F. ROBERT MacGONAGLE, Philadelphia Quartz Co., Philadelphia, Pa.

BEATER ADDITION

One of the oldest uses for the silicates in paper mills is as a beater addition. Two to four per cent silicate is added during the beating cycle and is later precipitated by alum. This precipitate is gelatinous in form and consists of a complex made up of aluminum silicate, aluminum hydrate, and hydrated silicic acid. The optimum pH for silicate precipitation is approximately 4.5 and the per cent retention when properly applied is about 60%. If 1:3.75 is used, the theoretical amount of alum necessary to precipitate 100 pounds of silicate is 25 pounds whereas, if 1:3.22 is used, 30 pounds of alum per 100 pounds of silicate is necessary. Silicates of soda often provide an economical and convenient method of obtaining the following improvements by properly considering the amounts of silicate used, the order of furnish additions, beating time, time before the alum is added, and the final pH in the beater.

1. Improved finish. The presence of properly precipitated silicate in the sheet tends to lay the nap and shows up as improvement in finish. A better pick test is often noticed.
2. Greater hardness. If silicate is added early in the furnish and alum added just before the beater is dropped, a definite improvement in hardness is indicated by the rattle and snap of the sheet.
3. Increased strength. When silicate is used, increases in bursting strength and tear are generally experienced.
4. Brighter color. On colored papers, colors are frequently brighter when silicate is in the sheet.
5. Increased retention. When silicate of soda is added to the beater it has the ability to increase the retention of size, starch, or clay. As the increased retention of one of these materials is important, experience has shown that the addition of silicate at the same time as the other material is added will increase its retention.
6. Ink resistance. Silicate is not added primarily to increase water resistance and does so only by its ability to increase the retention of the size. For oil-base inks, however, the presence of the silicate does aid in preventing the ink penetration and in this way can improve the printing qualities of the sheet.
7. Increased ash. By the retention of silica in the sheet, the ash is increased.
8. Shorter beating time. It is sometimes desired to obtain a certain degree of hydration as rapidly as possible and, by holding the beater on the alkaline side, the alkalinity of the silicate aids this hydration and permits attaining desired results.
9. Beater conditioning. This is particularly important in hard water areas where the system is not entirely closed. If some make-up water in the beater is hard when the size is added, the tendency is to precipitate the size with the calcium and magnesium hardness of the water and give spotty sizing. The addition of silicate in the beater at the beginning of the furnish enables it to react with the hardness of the water before the size is added and thus overcomes this difficulty.

RAG COOKING

Rag mills are confronted with the problem of cooking the rags and also getting them to a point of cleanliness necessary for rag stock. Caustic soda has been popular for this purpose for a long time, but the addition of some sodium metasilicate has proved beneficial. On one test, 4000 pounds of rags were cooked for 10 hours in 2200 gallons of water with 320 pounds of caustic, 80 pounds of metasilicate, and 25 pounds rosin size.

Results were excellent. In some instances, the rags are given a preliminary washing with hot water. The addition of some silicate (1:1) plus a little rosin size followed by 20 minutes of washing proved satisfactory for such an operation.

DEINKING

Considerable work has been done over the last several years in deinking waste paper. This interest was stimulated during the war years by the shortage of virgin pulp and the high groundwood content of the waste paper. The papers studied ranged all the way from ledger paper containing very little ink to highly inked magazine, roto, and varnished stocks. Caustic soda or combinations of caustic and soda ash have been popular in deinking formulas. Studies over the last ten years have definitely proved the advantage of substituting highly alkaline liquid silicate for part or all of these alkalies. Mills making such a substitution have increased their brightness at least 5 points. The theory behind such deinking practice is that it is more advantageous to remove the inks in solid form rather than dissolve them under conditions of high alkalinity and temperature and allow them to bleed back into the fiber. To avoid this, it is believed that the temperature during deinking should be kept within safe limits and 180°F. is suggested as a safe maximum. Silicate with a 1:1.6 ratio is recommended for deinking. Several of the inherent properties of the silicate are utilized. Improved wetting conditions plus dispersion of the solid ink as it is removed are two of the properties which aid in this process. In addition to this, it has been found that the silicates do not yellow the groundwood component of the sheet as does caustic soda. Some mills have attempted to build a highly alkaline silicate by causticizing a less expensive silicate such as 1:3.22 grades. This has proved successful in some mills, while in others the benefit of having the alkalinity originally tied up with the silica has been reflected by more satisfactory results. In order to attain even higher brightnesses the addition of the peroxides, sodium or hydrogen, to the silicates has been investigated. The use of the peroxides has resulted in even greater brightnesses.

PULP BLEACHING

An outstanding development in the last decade has been the peroxide bleaching of pulps. Initial work was done on groundwood, although the peroxide manufacturers have ample evidence that other pulps can be similarly bleached with beneficial results. It is reasonable to anticipate that peroxide bleaching of all types of pulps will experience a steady and rapid growth. The function of silicate in this process primarily is to stabilize the peroxides prior to bringing them into contact with bleachable material. Since the establishment of this use, evidences of other advantages of the silicates in improving the pulp quality have been noted.

WATER TREATMENT

Considerable time and study have been devoted during the last ten years to the application of the silica sols in the paper mills. If a silicate such as 1:3.22 is neutralized at a concentration great enough to prevent gelation, the silica is present in the form of a negatively charged hydrosol. As such a sol stands, the micelles grow and develop in the direction of a gel structure but, if the sol is further diluted, this growth is inhibited, giving a reasonable working life so that the properties of the sol can be utilized. The sol can be prepared either in batches or continuously through carefully regulated proportioning equipment. There are a number of reacting chemicals which can be used to neutralize the silicate and the choice, to some extent, depends on the specific use for which the sol is intended.

A good many mills have chemical treatment and filter plants to coagulate the turbidity and/or color in the raw water in order to deliver to the mill a water suitable for use in papermaking. The common coagulant for the impurities in such water is alum. The positively charged alumina coagulates the negatively charged color and turbidity in the water forming a floc which is settled, and the clarified water passes through filters. Under certain conditions alum alone is not a wholly satisfactory treatment. In the first place, in order to completely react and coagulate sufficiently, it is frequently necessary to use an excess of alum. This produces an excess of positive charge in the system, and this excess charge prevents complete coagulation of the finely divided alum floc. In addition to this, alum floc is light and feathery and easily broken up.

On the other hand, if sufficient negatively charged silica sol is added to the water, after a pin-point floc has started the resulting floc will be tough and heavier and, if broken up by agitation, will readily reform. Usually jar tests furnish a guide to determine proper dosages, but 5 p.p.m. silica sol represents a reasonable starting point for such a test. Also the isoelectric condition attained by neutralizing the excess positive charge due to the alum will enable the flocculation of the finely divided partially formed floc which then will not pass to the filter. Evidence of this phenomenon is easily observed by inspecting the clear well which becomes much more brilliant after the use of silica sol has been initiated.

Another use which has developed has been in white water treatment. Here, the silica sol forms a similar function in coagulating the white water solids and thus aiding their removal whether the saveall be of a sedimentation, flotation, or mechanical type.

Recent interest in preventing stream pollution has also stimulated silica sol studies for clarification of effluents to the streams and, here again, the sols have proved their ability to aid in this process.

OTHER USES

Another use for activated silica sol is on the paper machine. Here again, we have a condition where proper flocculation is desirable as the pulps go on the wire. The addition of activated silica sol ahead of the headbox has proved beneficial in numerous cases. The proper point of addition is subject to some checking as the size of the headbox and other factors have a bearing. It has sometimes been found that the entrance to the Bird screen gives optimum results and sometimes it is beneficial to introduce the sol into the fan pump. About 20 p.p.m. silica sol in the stock is a reasonable starting point for such a test. Usually the weight of the sheet will jump rapidly if the desired effects are being obtained.

Silicate of soda is an adhesive and so serves in incidental pasting jobs around the mill. For this purpose, 1:2.9 is suggested.

Silicate has also found use as a coating material to greaseproof paper. An example of this is in butter carton stock. A low alkaline silicate, such as 1:3.75 works best for this purpose.

An interesting report was made earlier this year on the use of sodium sesquisilicate to improve the rheological properties of high solids casein mixtures for roll coatings. Of some 450 compounds studied, sodium sesquisilicate seemed to the investigators to be most satisfactory.

Finally, every mill has concrete floors and considerable trucking, which presents a dusting problem. It has long been known that silicate of soda in the form of 1:3.22, if diluted in the ratio of 1 part silicate and 4 parts water and brushed on a dry concrete floor, which has been cleaned of grease, will penetrate the surface. If this is repeated twice, giving three applications in all, the silicate will not only fill up the voids in the concrete but will react with the free lime in the cement, forming a hard calcium silicate surface in the concrete, which will inhibit wear and prevent further dusting.

Presented at the meeting of the Empire State Section of the Technical Association of the Pulp and Paper Industry held at Alexandria Bay, N. Y.

LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel and Events

Chicago

The November meeting of the Chicago Section was held at the Chicago Bar Association, 29 South LaSalle Street, Chicago, on Monday evening, Nov. 20, 1950. The topic of the meeting was "Corrugated from A to Z."

A short business meeting was held before the program was turned over to the panel moderator, F. D. Long, Technical Director, Container Corporation of America. Mr. Long remarked that this meeting was a red-letter meeting in the history of the Chicago Section since it was the first program devoted to the corrugated container field. National TAPPI has recognized that no national group had been specifically organized to cover this field and, therefore, a corrugated container subcommittee has been set up. Mr. Long, who is chairman of this subcommittee, invited all members and guests present to participate in the activities of this committee and suggested that the Chicago Section could spearhead work in this field by tailoring future programs to this subject. Chicago is a "natural" as a leader in this work since more than 2% of the corrugated machines and sheet plants in the country are concentrated in or near Chicago. The out-of-town guests were welcomed by the moderator and thanked for their interest in the meeting. The attendance was 185. Among the visitors were:

T. C. West, Southwest Corrugated Box, Fort Worth, Tex.
D. P. McNeily, Fort Wayne Corrugated, Hartford City, Inc.
E. W. Amon, A. E. Staley Co., Decatur, Ill.
J. H. Wrightsman, Staley Co., Decatur, Ill.
Milton Barle, Hubinger Co., Keokuk, Ia.
Roy Watson, Hubinger Co., Keokuk, Ia.
J. V. Bauer, Hubinger Co., Keokuk, Ia.
J. L. Ferguson, J. L. Ferguson Co., Joliet, Ill.
Burt Mendlin, Cornell Wood Products, Milwaukee, Wis.
W. R. Tobin, American Boxboard, Grand Rapids, Mich.
Art Gault, Iowa Fiber Box, Keokuk, Ia.
C. D. Kelly, Clinton Foods, Clinton, Ia.
J. M. Newton, Clinton Foods, Clinton, Ia.
A. C. Junge, Clinton Foods, Clinton, Ia.
David Bruning, The Mengel Co., Louisville, Ky.
W. Malinas, S & S Corrugated Paper Machinery, Brooklyn, N. Y.
Fred Katzung, A. Geo. Schulz Co., Milwaukee, Wis.
Ray Schmidt, A. Geo. Schulz Co., Milwaukee, Wis.
Chester Risseeuw, A. Geo. Schulz Co., Milwaukee, Wis.
H. W. Neuschaefer, Downing Box Co., Milwaukee, Wis.
B. P. Bowen, Downing Box Co., Milwaukee, Wis.
Joseph Vukovich, Downing Box Co., Milwaukee, Wis.
M. W. Thiem, Hoerner Corp., Keokuk, Ia.

The panel members were then introduced and S. F. Thune, Sales Manager, Midwest Division, National Starch Products, Inc., was the first speaker.

Mr. Thune reviewed briefly the basic theory of the starch process for combining corrugated board. The use of starch depends on applying a raw starch suspension and using the heat of the machine to gelatinize and dry almost simultaneously. The original process was developed with standard pearl cornstarch because it was most readily available at minimum cost. Recent research has developed chemically modified starches specifically designed to obtain characteristics which would give improved results and better machine efficiency. The development has led to modified starches which have higher viscosities, lower gelatinization temperatures, better breakdown resistance on prolonged agitation, and greater stability on cooling. The result of this development lower starch requirements, higher speeds due to lower swelling temperatures, better bond due to greater uniformity of starch suspension, and better results with V-board.

The present world situation makes a discussion of adhesives for V-board particularly interesting. The most widely used adhesives for this type of board are the starch-urea-formaldehyde formulas. The use of urea-formaldehyde requires an acid medial which eliminates the caustic from the formula. Lack of caustic raises the gelatinization temperature and causes slower machine speeds. Much research is being done on waterproofing agents in alkaline media, but nothing tangible can be reported to date.

The supply and availability of starch is currently a major concern of everyone. There is an ample supply of the basic raw material—corn—and no shortage should occur unless one is artificially created as in the later part of World War II. The plant capacity of the wet millers is somewhat greater than at any time in the past and should be capable of taking care of the normal needs of industry. The backlog of orders created by the increasing consumption and increased inventory buying following the Korean outbreak is being reduced and the situation should be normal in the near future. Also the alkali strike coincidentally created a silicate shortage which also put more pressure on starch producers.

As a final point the work on synthetic resin adhesives for use with ungummed tapes and the glued lap containers was mentioned. Many in the industry seem to feel that the glued corner box is the coming thing. Several different types of equipment are already available for gluing these joints and these are currently being improved.

Art Sperling, Plant Engineer, Downing Box Company, followed Mr. Thune with a discussion of "Preventive Maintenance in the Box Shop." He defined preventive maintenance as: "A means by which, through scheduled periodic inspection of buildings and equipment, the need for repairs may be discovered prior to point of failure, and shutdowns can be planned and repairs scheduled in advance of costly

Chicago Section Officers (1950–1951): J. R. Fulghum, R. O. Ragan, A. K. Roach, A. Duetsch, and C. H. Krebs

and annoying breakdowns." In developing a maintenance program responsibility must be delegated and a definite line of responsibility for repairs to buildings and equipment assigned. All maintenance personnel should be informed of this line of authority. The department must be set up with competent supervision, adequate and balanced manpower, and good tools and machines. Simple workable schedules for processing and receiving regular maintenance or trouble-shooting requests must be worked up. This schedule should include a form for weekly maintenance requests to be filled out by each department supervisor and due on a specific day every week. This form should list all required repairs of broken material and all items to be inspected which the supervisor thinks may give trouble. After receiving the maintenance requests the maintenance department has the job of determining the time involved in doing each job and planning and arranging for the completion of the work. A form is used for the assignment of the work and this form is given to the person who will do the job.

The preventive part of the maintenance program requires schedules for inspections. The past experience of the men in the shop, the manufacturer's recommendations, and common sense form the sources of inspection data. Forms or check lists giving the time for inspection, items to be checked, who is responsible, what is found, and the action taken must be made up. The preventive inspection jobs should be paralleled with the regular maintenance requests as much as possible.

The factors usually given as hindrances to the formulation and carrying out of a good preventive maintenance plan are the increase in clerical and supervisory employees required, the already too large load of regular maintenance requests, and the fact that continuous operation provides no down time for inspections until breakdown occurs. To overcome these objections concentrated effort should be made to clean up all maintenance requests by use of outside help and contractors, the department supervisors should go out of the way to find things with which to load their request sheets, and an educational program should be instituted to teach supervisors more about their equipment so they can locate troublesome noises, belts, etc. Better planning by the maintenance department supervisor and the gradual building up of the preventive maintenance aspects, starting perhaps with new equipment, will also help. A strong housekeeping program is vital to a good maintenance system. On their corrugator they have a method whereby all down time is recorded—slitter turnover, jam-ups, etc. These data are summarized and divided into mechanical and operational. Then considerable thought is given to methods of reducing each source of down time.

Thus the main features of a simple workable system are:

1. Establish a top-notch maintenance department.
2. Establish channels for receiving and processing work requests.
3. Develop sound work scheduling procedures.
4. Delegate responsibility for upkeep of buildings and equipment.
5. Maintain scheduled periodic inspections.
6. Keep your house and system in order.
7. Know what your men are doing and when and where.
8. Keep repair and inventory records.

Finally, preventive maintenance should be bolstered with the complete cooperation of management and the department supervisors.

Don Santmyers, Industrial Products Development and Service Representative for E. I. du Pont de Nemours, Inc., Grasselli Division, opened his remarks by stating the main advantages of sodium silicate as an adhesive in corrugated board manufacturing. These advantages which have enabled it to enjoy over half a century of use are: low cost, uniformity of adhesive solution, shipped ready for immediate use without mixing, and ability to produce a smooth, firm board of highest crush and compressive strength. The main disadvantage of silicate adhesives is adhesion to hot plates and other machine parts, and this can be minimized by the use of normal amounts of adhesive, scheduling operation on decreasing board width, or use of corrugating medium 1/4 inch narrower than liners.

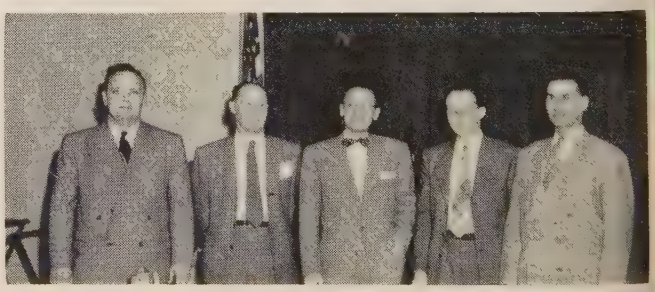
Another operating problem is that of so-called "dusting." "Dusting" occurs because all the silicate does not penetrate into the board and it is overdried on the hot plates and flakes off. Moisture near the surface is needed to get the silicate to wick into the board. Mr. Santmyers demonstrated this by using a moistened cellulose sponge and a dry cellulose sponge to blot water that was poured on the table. The moistened sponge picked up all the water, whereas the stiff, dry sponge did not.

He then went on to quote test results from a study made at the University of Michigan to show the increased rigidity and compression strength obtained by using heavier silicate films. The proper spread of sodium silicate can be determined by examining the glue pattern on the board. Once the correct pattern has been determined, glue roll clearances, which govern the amount of adhesive application, are maintained by the use of a feeler gage. The most important single factor in the use of silicate for corrugating is the condition of the adhesive rolls and the clearances used. A rule-of-thumb value of 1 pound of silicate per 0.001 inch glue roll clearance was used to compute the increased costs incurred by use of large clearances. Roll clearances should be checked and adjusted; if they get out of line because of wear the rolls should be ground or replaced. If the wear exceeds 0.002 inch consideration should be given to replacing the rolls—the glue savings will pay for the replacement in a short time.

The adhesive bond should be uniform across the width of the sheet and have a slight excess of silicate on both sides of the line of contact at the double-face bond and one side at the single-face bond, forming shoulders, which reinforce the board. Only sodium-silicate adhesive produces the added strength of a load-bearing shoulder.

The final talk was presented by C. J. Zusi, Vice-President, Container Laboratories, Inc. His discussion of "Testing and Quality" was prefaced with the question, "How good are you?" He continued by stating that most people are interested in knowing how they measure up to what is expected of them and what they expect of themselves. The manufacturer needs an evaluation of the efficiency of his fabrication methods and the strength of the resulting box. The user must know how well his package will perform the functions for which it was designed. The only way to find out and to assure oneself that a continuing supply of satisfactory containers are being produced is to have quality control tests made regularly. This is necessary because materials vary and fabrication may fall below standard.

The kinds of tests to be made depend upon the purpose of the check. There is no universal program—it must be set up to suit the purposes for which the tests are to be made. The purposes of the maker of the boxes are attained by making tests on the component materials, the flat sheets of combined board, and the empty containers. If the ring stiffness test along the grain of the board and along the grain are known, it is possible to forecast what the boxes made from those



Corrugated A to Z panel, l. to r.: Art Sperling, C. J. Zusi, S. F. Thune, D. Santmyers, and F. D. Long

sheets should withstand in top-to-bottom and end-to-end compression. Comparison of the actual compression test results with the forecasted result yields a fabrication efficiency rating. The compression tests are used for this purpose because they best reflect important defects which sometimes occur in the manufacture of a corrugated box.

The problem of the user of the boxes is quite different from that of the maker. He wants to know whether the box will function satisfactorily in actual use. Testing programs for users should be the result of the combined efforts of the shipper's representatives and the testing laboratory after study of the nature of the product shipped, the filling, handling, storing, and shipping hazards, and merchandising conditions. The tests must measure the properties desired in the containers: piling resistance; resistance to end impact; score strength; cushioning qualities, etc.

There is a wide variety to tests which might be included in a program. Convenience and cost must be considered, obviously, and to some extent these will govern the number of specimens tested and the kinds of tests to be made. Sampling is an important point because, if the specimens are not representative of the lot being checked, the tests cannot be worth much.

Costs tend to make tests on empty containers preferred to tests on filled containers. The tests on filled containers should be made in a cycle designed to simulate the service conditions expected in the use of the containers. Vibration, incline-impact, drop, drum, and compression tests are some of the tests made on filled containers.

The fundamentals of a sound quality check program can be seen to be: (1) clear definition of the purpose, types, and performance levels expected of the various tests; (2) adequate and truly representative sampling; (3) performance of testing on suitable machines operated by competent personnel and interpreted by qualified technicians; (4) performance of tests at regular intervals. Following these principles, quality check tests can provide the means for insuring a continuous supply of containers meeting specifications and for making the packaging dollar go farthest.

Question: What flat crush per square inch do you consider necessary to get a good printing job on average printing on kraft-lined containers? What do you think an average over-all flat crush should be?

Mr. Zusi: A good print job can be obtained with a wide variation in flat crush. The corrugations can be smashed and a good print job still made. An average over-all flat crush depends on flute size and corrugating medium used. A very rough general answer is: on A-flute approximately 200 lb. per 9 square inch; on B-flute approximately 280–300 lb. per 9 square inch; and on C-flute approximately 250–260 lb. per 9 square inch.

Question: What can be done to prevent bleed-through of silicate on lightweight liner? Can build-up of silicate on machine parts be prevented?

Mr. Santmyer: Bleed-through can be prevented by operating the preheater to drive moisture away from the side to be bonded. Prevention of the build-up of silicate was covered in the talk. Once it has occurred the only thing to do is to scrape. The main point is to use normal amounts of adhesive. Wiper blades at edges of the sheet can be used to keep bead of silicate from carrying over to hot plates. Auxiliary equipment can be used, particularly on the double backer, to lift single-face board off the adhesive rolls and thus keep slug of silicate from forming between the flutes and carrying to hot plate section.

Question: Can a modified starch be made with a gel temperature about 130°F. to be used with urea-formaldehyde? If so, is it available?

Mr. Thune: A modified starch can be made with a gel temperature as low as 130°F., but doubt if it can be used commercially because of thickening in the pan.

Question: What has caused the decreased corrugator roll life experienced in the postwar period?

Mr. Sperling: Who has experienced decreased roll life? Our present B-flute rolls are chromium plated, are still producing board leaving the corrugator with a caliper of 0.125 inch, have been running for a year at speeds up to 500 ft. per min., and have produced 120,000,000 lineal feet of board. The rule of thumb lineal footage from regular rolls is 60,000,000—nitrided rolls give a little bit more.

Audience: Nitrided rolls will last longer than chrome-plated rolls.

Mr. Sperling: We haven't used nitrided rolls. Has anyone experienced decreased roll life?

Audience: No decrease.

Audience: It depends on the corrugating medium; with straw you get less life, with semichemical mediums more.

Mr. Sperling: We have run little straw, and this may account for our long life.

Question: What are the best present tests for measuring the quality of adhesion?

Mr. Zusi: There is no standard test method. There is the Thwing-Albert finger equipment which gives bonding strength in pounds per lineal inch. The compression test shows up defects of adhesion remarkably well.

Question: At the 500 ft. per minute speeds on the single facer, is there an advantage in starch or silicate adhesive?

Mr. Sperling: We have run starch for over 10 years and so I couldn't give an opinion on that. Is there anyone here that could?

Mr. Long: May I suggest that the starch and silicate suppliers settle that question out in the hall!

Question: Several years ago many plants switched from A and B to C-flute. What is happening today; are we continuing to switch to C, or are we switching back?

Mr. Sperling: Several years ago we switched to C-flute, but felt the pressure and are now running B-flute again. We try to run as much B-flute as we can. I don't think that plants are making an all-out effort to go to C-flute because of customer pressure.

Question: Do you have any drum or compression comparisons of glued manufacturers joints versus taped joints? Also any cost comparisons?

Mr. Thune: Drum and compression tests have been made, however, the results cannot be made public as yet. I believe the glued joint is lower in cost.

Question: What are the outstanding developments on corrugators which account for present speeds?

Mr. Sperling: These are not named in order of importance—the quality consciousness that has pervaded makes operators get better knowledge of their machine; shaftless roll stands; improved rotary cut-offs; improved take-offs; improved corrugating mediums; increased steam pressures giving more heat to the machine; preheaters.

Audience: A.C.-D.C. drives eliminate mechanical drives.

Audience: Increased diameter of corrugating rolls.

Audience: Increased machine widths.

Question: With the new modified starch used at lower concentration, is added drier capacity needed? Does the starch demand a premium price?

Mr. Thune: No added drier capacity is necessary. Several modified starches are on the market; some command a slight premium, others do not.

Question: Are the following suitable for use in the corrugating industry: wheat starch, potato starch, tapioca flour?

Mr. Thune: Any starch can be used if properly formulated. Questions of cost, availability, and quality all contribute to the decision of which to use.

Question: What test can be made, on a corrugating medium, which will forecast the strength (flat crush) of the fabricated board?

Mr. Zusi: We have found that a correlation exists between the MD ring stiffness and flat crush test on combined board with one medium. A series of tests on one medium can be used to draw up curves to predict crush with fair accuracy. This test shows the most promise of those studied.

Question: How do the recent tests on corrugated V-board compare to the results obtained in the last war?

Mr. Zusi: At present corrugated V-board is not quite so good as during the latter part of the last war. This statement does not apply to the wet and dry mullen—which are slightly better. The ply separation is worse. It is believed that this is not due to poor adhesives, but due to the fact that many people are making V-board that have never done so before and those that have done so before have forgotten and everyone is still learning.

Question: Against what production factors should maintenance cost be graphed?

Mr. Sperling: We graph our maintenance cost against MSF produced and we get anywhere from 7 to 15 cents per MSF. You could also plot maintenance cost against cost per MSF to produce, however, the plant might run wild in production while maintenance costs remain the same. Another idea is to plot maintenance on each major operation (corrugator, printer-slotteters, etc.) against the cost of those operations.

F. D. Long

Lake States

The second meeting of the Lake States Section was held at Green Bay, Wis. The group met at 1:30 p.m. at the Green

Bay Pulp and Paper Company offices and was provided with guides for a trip through the mill. At 2:45 members were reassembled at the Northland Hotel to hear three speakers discuss semichemical pulping in their respective fields and operations.

Karl Fries of the Rhinelander Paper Company presented a talk on the application of semichemical pulps to specialty papers. Dr. S. R. Parsons of Consolidated Water Power and Paper Company presented data and experiences collected in Consolidated's laboratory and operations. Dr. W. W. Marteny of National Container Corporation, Tomahawk, spoke on equipment in processing semichemical kraft pulp. A question and answer period followed the talks.

Preceding the dinner a social hour was held from 5:30 to 6:30 and following the dinner a very interesting paper was presented by A. Newell Rumpf, Vice-President of the Harris Trust and Savings Bank, Chicago. Mr. Rumpf discussed Paper Mill Finance and Financing. The attentiveness of the group during the presentation and the very favorable comments by members later attested to the interest of the audience in this type of paper.

One of the largest groups gathered in recent years, 176 members, attended the meetings. The regular membership was augmented by a number of the top executives of mills in this area who were sent a special invitation to hear Mr. Rumpf talk.

A. P. Adrian

Lake Erie

Forty-six members of LEPCA were both entertained and educated in the art of "Gravure Printing" at the second meeting of the season held on November 17. The subject matter was well covered by two highly competent speakers. Frank B. Johnson of the Intag Division of the Interchemical Corp., Cleveland, Ohio, presented a paper entitled "The ABC's of Gravure." Joseph Martin of the Champlain Company, Inc., Cleveland, Ohio, discussed the subject from the press manufacturer's viewpoint.

The ABC's of Gravure

FRANK B. JOHNSON

Gravure, the baby of today's three important printing processes, was first printed from a web in England on Aug. 1, 1895. In America, the first rotogravures were made in 1905. Going back some 500 years to the time of Pope Nicholas V, we find evidence of the founding of the technique which gave the world intaglio printing. Nicholas V was a patron of the arts, builder of the Vatican, founder of its library, planner of St. Peter's. He commissioned a goldsmith named Finiguerra to execute a "Pax," or religious medallion representing a scene from the Life of Christ. Finiguerra, one of the great craftsmen of his day, incised this scene in a golden tablet. To prove the perfection of the engrailings in the design, he hit upon the idea of mixing lampblack with oil, smearing it over the design, and wiping off the excess from the top. The impression he made of that golden tablet still hangs in the print room of the Paris library.

There were many men who, from the 15th century on down through succeeding centuries, contributed to the various processes from which present-day gravure was evolved. But it remained for Karl Klie (or Klietsch), a Bohemian, to combine the various ideas into a workable method for producing photogravure. The fundamental principles which he evolved are basically those in use today.

Gravure is a photo-mechanical method of intaglio printing whereby tone values are produced from incised cells or "dots." In *letterpress*, the image area is printed from "relief" dots, i.e., raised surfaces. In *offset*, the image is printed from a flat or nealy flat surface. Both letterpress and offset utilize the half-tone screen for reproducing tone values. The half-tone screen produces a nonuniform surface area, wherein the highlight tones are reproduced by small dots, widely spaced, while the shadow or dark areas are reproduced by larger dots, closely spaced. These nonuniform half-tone areas all carry a *single, uniform* thickness of ink.

The gravure screen, on the other hand, is composed of small, uniform cells which can be etched to various depths in a copper surface. The process therefore achieves its tonal values by the various depths to which these cells are etched, thus enabling them to deposit an actual thickness and thinness of ink film on the stock. In other words, it has a uniform surface area, but a variable thickness of ink. These, then, are the reasons why gravure has the richness of tone and the photographic result which distinguishes it from the other processes.

Of course, gravure, like the other printing processes, has its advantages as well as its limitations. Among the advantages of the process are:

1. Photographic Quality. It can use almost any type of reproduction for copy. Although the better the copy, the better the results. Since *continuous-tone* negatives and positives are made, it is desirable that the original copy contain no screen pattern, since the gravure screen will tend to form a moiré effect with it.

2. Tone Range. Because the process has the longest tone range of any of the processes, its use is particularly desirable when photographic effect is a major desire. But brilliant results are obtained through the greater "coverage" which is reproduced on the printed sheet.

3. Fine Detail. The process reproduces fine detail even *on some* coarse surfaced stocks. The common gravure screen has 150 lines to the inch or 22,500 dots or cells to the square inch. Due to the larger number of "dots" per unit area, as well as to the variable depths of the cells or dots, greater coverage is obtained on the printed sheet.

4. Inconspicuous Screen. The screen pattern of 22,500 dots to the square inch is not discernible to the naked eye. Consequently the effect is that of continuous tone reproduction.

5. Prints on Wide Range of Stocks. Gravure prints on a wide range of materials from the glass-smooth surface of cellophane, through semifinished and coated papers, to boxboard. Of course, there are certain factors in each case which must be controlled in order to carry the dot formation. For irregularities in the surface of the stock, if they approach the cell diameter of 0.005 inch, will cause partial or complete loss of contact between paper and ink.

6. Economical for Long Runs. High-speed presses and fast-drying inks give rapid production, making the process economical for long runs. The copper cylinders may be chrome plated which increases the wear resistance of the cylinder, enabling them to produce literally millions of impressions. I can recall a catalog run of over 7 million signatures from a single set of cylinders.

The above are some of the many advantages of the gravure process. But there are several important limitations which must not be overlooked when considering the process. Chief among these limitations are:

1. Etching of Multipage or of Repeat Design Cylinders. Unlike letterpress, where the various pages or component plates are etched separately, the gravure cylinder is covered with 16 to 24 imposed pages, or with repeat designs. In other words, we have the *simultaneous etching* of a large number of pages or designs which must be uniform and even. There are many factors which make this difficult to achieve, although the industry is making great strides along this line.

2. Proving Before Run. While some cylindermakers have proving units, many lack the facilities or find them too

expensive and too inconclusive to use. Therefore one of the limiting factors of the process is the inability to prove cylinders before the run. Most proving units will give you an indication of a cylinder's value, but the ultimate result will only be determined under actual running conditions.

3. Corrections Hard to Make. Corrections of tone values or of other errors are often slow, expensive, and at times impossible to make. Remember you are dealing with a cylinder of many pages or of various designs, hence your correcting problem is often multiplied. It is not only costly to remake cylinders, but press delays are expensive, and the cost of a loss of schedule is unpredictable.

4. Type Impaired by Screen. If your gravure subject carries type, then from a strictly typographical standpoint, gravure type is not equal to letterpress. The gravure screen breaks up the type into rough and uneven edges. This is especially true of small-size type or type having fine serifs. However, from a layman's standpoint, a few people are aware of this defect.

5. High First Cost of Cylinders. Large-size gravure cylinders cost several hundred dollars each, thus necessitating great initial expenditure. While the cylinders can be used over and over again, their surface is very delicate and the slightest blemish or defect will print. The cylinders must have a mirrorlike surface, free from abrasions and scratches—which require careful handling and protection.

These are only a few of the many advantages and limitations which could be mentioned. Suffice it to say that each of the three major printing processes has outstanding advantages which makes it the best method for producing specific types of work.

As you all know, the use of screens, whether halftone or gravure, gives only a percentage of coverage of ink on paper. In other words, no process produces a "continuous tone." There are inherent losses in any photographic process. Retouching and finishing helps to produce the effect and the detail desired. Copy often looks good visually but reproduces poorly optically. Printing results vary and are limited with different papers and inks, by the mechanics of the press and the operating conditions, etc. Thus we become aware of the many technical, chemical, mechanical, and production factors involved in successful printing.

Briefly outlining the preparational end of gravure printing will give you an idea of some of the problems involved. For the sake of simplicity, we will asume the production of a monotone catalog job. The principles involved in four-color work or for specialty jobs are essentially the same.

Copy, for gravure reproduction may consist of photographs, oil paintings, water colors, wash drawings, pen and ink sketches, and the like. If photographs are used they should be glossy prints for best optical results in sharpness and detail. Mat-finished prints act as a diffusing medium before the camera and results in loss of sharpness and detail. Retouching on photographic prints should be done in a neutral gray. Chinese white produces a highly contrasting result; yellow grays tend to reproduce darker optically than they appear visually; blue grays reproduce lighter optically. If color copy such as water colors or oil paintings is used, remember that you are going to have to reproduce with three colors and black—the full range of an artist's palette.

From the copy, a *continuous-tone* negative is made. A process camera is used except that no screen gear is required. Most of the work is now down on dry plates, either film or glass. Keep in mind that the negative is opposite in tone values to those on the original copy, i.e., white areas on the copy are dark on the negative, while the dark areas of the copy are white on the negative.

Retouching, by means of dyes, pencils, or scrapers, may put back certain details lost by the photographic process. The various components of a page or design are then assembled into a *layout*, following a "dummy" provided by the customer. Here, too, type that is to be in tone, is set up to be flashed into the positive, or reverse type is achieved.

The completed continuous tone negative layout is returned to the camera room, where a *continuous-tone positive* is made either in a contact vacuum frame or on a camera. At this point, a "densitometer" is often used. This is an instrument for measuring photographic densities, especially in the highlight and shadow areas. Where a group of miscellaneous subjects are to be laid and etched on the same cylinder, uniform densities of the positives improve etching control as well as final quality.

The positives are then retouched—to sharpen detail or to remove defects—and finally set up with type, if it is to be used. Type matter may be film positives, bronzes, or the like.

Usually a *red print* is made of the completed positive, which may be sent to the customer for final approval of tone position and type correctness. It is at this point that a customer may make type or tone changes at a minimum expense. Once the form has been imposed, laid, and etched on a cylinder, the making of corrections becomes increasingly expensive.

The individual positives are then "grouped" or *imposed* into forms for the subsequent operations of carbon printing and laydown. Imposition depends on the job size, the press, the folders, etc., to produce the desired signature make-up.

Briefly summarizing the steps above described: From original copy, we produce a continuous-tone negative; from the continuous-tone negative, we make a continuous-tone positive; a red print is made from this positive for customer approval; and finally the continuous-tone positives are imposed into forms for carbon printing. These steps constitute the first phase of cylinder making.

To obtain a *resist* which controls our *etching operation*, we enter our second phase of cylinder making. To do this, we must transfer the image on the positives to the cylinder by photomechanical means.

Carbon printing is the transfer medium used for putting the work on to the cylinders. In letterpress or offset, the flat metal plate to be etched is coated with a light-sensitive material and the line or half-tone work is printed directly on it. In gravure, due to the use of cylinders, the direct sensitization of curved surfaces is difficult to achieve, hence the use of "carbon tissue."

Carbon tissue is a gelatin-coated paper, the gelatin containing an inert-colored pigment. Carbon tissue, as such, is insensitive to light. The tissue is made light-sensitive by immersing it in a solution of potassium dichromate, squeegeeing it to a ferrotype, and drying. The potassium dichromate undergoes a chemical change when exposed to an arc light, hardening the gelatin in proportion to the amount of light that has reached it. The gelatin is *hardened* through the *screening* and *carbon printing* steps yet to be described. However, the light action on the gelatin renders it insoluble, creating a *resist*, that forms the basis for the etching technique.

The copper cylinder is plated in an acid bath, then finished with stones or other grinding media to a mirrorlike finish preliminary to lay down. Prior to lay down of the screened and printed carbon tissue, the cylinder must be thoroughly washed and made chemically clean.

As previously mentioned, the gravure screen consists of transparent lines and opaque cells. There are a number of variations in screens, but the conventional screen has 150 lines to the inch or 22,500 cells to the square inch, and a ratio of line to space of 1 to 3. That means there is about 60% printing area, with approximately 75% coverage due to ink spread in printing. The primary purpose of the screen is *to form an unetched pattern* which supports the doctor blade on the press, thus preventing the wiping out of ink from the etched areas.

With this in mind, we place the sensitized carbon tissue be-

hind the gravure *screen* in a vacuum frame. An arc light in front of the screen passes light rays through the transparent lines of the screen, hardening the tissue to a considerable depth, and thus providing a pattern of thick lines of hardened gelatin which will not etch. The opaque, or cell-dot areas remain unaffected.

Next the screened tissue is placed on the imposed form of continuous-tone positives in a vacuum frame and exposed to light. This is called *carbon printing*. Here the light quickly penetrates the highlight or lighter areas of the positive, hardening the underlying tissue to a considerable depth. On the other hand, the dark or shadow areas of the positive inhibits the action of the light on the tissue, allowing very little "hardening action." The result is the formation of a *resist* of varying thickness and thinness of hardened gelatin. The areas which have not been light struck remain unhardened and are soluble in water and removed in the *developing* step.

The screened and printed carbon tissue is then *laid down* on an accurately inscribed copper cylinder which corresponds to the imposed form. The principle of lay-down is similar to the old decalcomania transfers used in childhood. The carbon tissue is positioned on the cylinder, taped down and fed between a rubber roller and the cylinder, while cool water is poured between the tissue and cylinder. The tissue is thus rolled under pressure into intimate contact with the copper surface and adheres to it, since the water excludes the air between the surfaces, and a film of water is absorbed by the gelatin.

After the tissue is applied to the cylinder, it is thoroughly dried and then lowered into a pan of cool water. Gradually, the water is warmed, the paper backing of the carbon tissue is loosened and pulled off, exposing the gelatin layer adhering to the copper.

The gelatin layer directly beneath the paper backing has not been "hardened" by light action, so remains unchanged and will dissolve in the warm water. This leaves the hardened or insoluble gelatin resist adhering to the copper. This particular operation known as *developing* produces the *gelatin resist* for the etching step. The resist is cooled gradually to harden it and finally dehydrated with alcohol to fix it firmly to the copper. This completes the "second phase" of cylinder making.

Certain areas of the resist which are not to be etched are *staged* or blocked out with an acid resisting asphaltum. Some shops etch type and tone areas together, while others prefer to etch them separately. A separate etching of the tone areas produces a wider tone separation.

The purpose of the *etching* operation is to etch selectively through the thickness and thinness of hardened gelatin of the resist, to produce the incised cells known as gravure. The etching procedure is a rather involved one requiring every precaution to control the rate of etching. In principle, the etching acid will penetrate the thick layer of hardened gelatin slowly, consequently will etch only to a very slight depth. On the other hand, the acid will rapidly penetrate the thinner layer of hardened gelatin, thereby etching deeply into the copper cylinder. The depth of etch is thus controlled by the gradated thickness of hardened gelatin obtained through the tone range of the positive itself. The screen lines will remain unetched and thus provide not only the walls of the cells, but will act as a support for the "*doctor blade*" on the press. After etching, the gelatin and the asphaltum are washed off the copper cylinder.

"*Finishing*" is the last, but one of the important steps of the process. The finisher, by means of burnishers, gravers, roulettes, charcoal, emery paper, and other finishing tools, is able to remove or to minimize the defects in the cylinder. The cylinder is now ready for press.

In a rotary gravure press, the copper cylinder revolves in a bath of fluid ink, or the ink may be applied with special applicator devices. The surface ink is removed by a flexible steel blade known as a *doctor blade*. A rubber impression roller then presses a web of paper in contact with the cylinder. The ink remaining in the incised cells or dots on the cylinder is transferred in this way to the paper. The ink solvents are evaporated out by means of heaters and the web may be cooled by air or by running over cold-water drums.

As can be seen from the above, the ink must be very *fluid* in order to fill the minute cells completely and rapidly. It must have sufficient *cohesion* to remain in the cells against the centrifugal force of the fast rotating cylinders. It must have *low adhesion* so that it can be wiped cleanly from the cylinder, and it must harden or *set* immediately without going through a sticky stage. To design or formulate an ink properly for specific press requirements, we need to know: (1) the color, (2) the speed of press or web, (3) the kind of stock to be used, and (4) the press characteristics.

The subject of gravure inks is a very specialized and highly technical one; hence it cannot be gone into at this time. Basically gravure inks differ from both letterpress and offset inks, inasmuch as they dry mainly by evaporation and only slightly by penetration. It is an intimate mixture of coloring matter (pigments or dyes), binder or resin, and highly volatile solvents, all finely ground so that the pigment is well dispersed and has no abrasive qualities. Naturally these basic materials are often mixed with other chemicals in order to provide the special properties which are required. Considering the wide range of their use from candy wraps to soap cartons, from plastic drapes to lard packaging, it is easily apparent that the formulation and testing of an ink for a specific purpose is a tremendous task.

As to the material or stock to which the ink is to be applied. For catalog work as an example, a 39-lb., short-fibered, calendered paper is an excellent average stock. The stock must be free of chemicals that will affect the copper: sulphite papers for example contain sulphur which will tarnish the copper cylinder to such an extent as to "fill in" the cells. While coated papers are sometimes used, they tend to resist the proper lay of ink unless the manufacturer has controlled the rate of absorption by the addition of compounds soluble in gravure solvents. Then too, some coatings are friable and break off the paper surface tending to fill in the cells, so that tone values are lost. If the stock is rough and not easily compressed by the impression roll, there will be a loss of contact between the stock and the ink. Certain very smooth materials such as cellophane have "greasy" or wax-like films that will resist the ink unless certain solvents are added which penetrate this film layer. Thus a stock which is to be considered for gravure printing must be carefully tested before a decision is made as to its suitability. We urge our customers and their suppliers to submit these stocks to us for careful and rigid testing, so that all concerned may be entirely satisfied with a quality end product. Here again we cannot cover a field which is highly specialized and technical, at this time. For example if you are going to print a package by gravure, an ink formulator would need to know:

1. If the package is going to be exposed to sunlight; to heat; to moisture.
2. Whether the package be handled often.
3. If the package is to contain soap flakes, oils or fats, food stuffs, etc.
4. If the package is to be of boxboard, paper, foil, cellophane, plastic, etc.

The problems involved are manifold.

Now for one last statement in closing. Another interesting variation of the gravure process is known as the "Dultgen Process." Many of you have undoubtedly heard of it—for it is being widely used for four-color reproduction by national advertisers. The Dultgen Process incorporates the half-tone dot into the gravure process. This eliminates the need for the conventional crossline gravure screen. Briefly the process is as follows:

1. Continuous tone negatives are made for each color and for black.

2. Two positives are made from each continuous-tone negative: one, a *continuous-tone positive*, the second a *half-tone positive*.

3. In carbon printing on to the sensitized carbon tissue, the half-tone positive is printed first. This is removed, and the continuous-tone positive registered into position on the carbon tissue and printed.

4. If only the half-tone positive was printed, the etched dots would be of approximately the same depth and would lack the variations of tone characteristic of gravure. In other words, we would have an inverted half-tone cell. Keep in mind that the surface area will be variable exactly like a half-tone screen, i.e, small dots widely spaced for the highlights and large dots close together for the shadow areas.

5. To give the dot correct tonal depth, the continuous-tone positive is imposed on the image of the screened one. This exposes the tissue to the varying tone values of the picture, which when etched produce dots that are not only variable in diameter (from the half-tone positive) but variable in depth also (from the continuous-tone positive).

We all carry excellent examples of intaglio printing in our pockets. Look at your dollar bills—or at the 10's and 20's when you have them, or at the postage stamps on your morning's mail, and you will see gravure printing at its finest.

Remarks by Joseph Martin

"During the past two decades the nature of the graphic arts trade in the United States has changed from a heavy proportion of letterpress production to include other methods of printing, and specialized types of equipment to better facilitate the production of increased volume and specialty items which are required and are now typical of the industry.

"With the increase in the market for package printing a stimuli also caused the development of specialized packaging materials, such as cellophane, pliofilm, glassine and foil, and in addition, new types of paper and board. These materials afforded additional attractiveness to product appearance and were in great demand. However, the new materials were also found to be difficult to print and handle, and much of the new packaging equipment dictated the use of roll feed. The average existent printing equipment was unsuited to this type of production, and now label printers are confronted with an additional complication. Many of their customers are converting from cut labels to roll-fed labels on a gradual basis, and it is therefore necessary to furnish them both individually cut labels and labels, or wraps in continuous roll form. To meet this requirement it is necessary that a roll-fed printing press be equipped with both sheeter and rewind.

"Along with this trend for more colorful and elaborate wrapping materials and labels, there has been noted a keen interest in dressing up the folding paper box or carton.

"Most of you are familiar with the printing processes of offset and letterpress. Rotogravure, as it is being used today, has not as yet become as well known as these other methods.

"Mr. Johnson has covered many of the technical aspects of the gravure process, so we are supplementing this information with a technical bulletin which has been published by the Technical Trade School of the Pressmen's Home, Tennessee.

"I shall try to give you an idea of what can be done with rotogravure and how it may be used; so that you can judge how a gravure installation may apply to certain types of your own production.

"Letterpress and offset, the foremost methods of printing, are each, in some way, more ideally suited to certain types of production than the other, and it can be said that neither method is the only one to use. Each has its own place in the Graphic Arts.

"There are four well-defined categories of gravure printing. The first two to be developed in this country extensively were publication and textile printing. The latter, frequently referred to as intaglio, is of little concern to us. The former, while occupying a very prominent position, is also not in keeping with the interests of most of you. It is sufficient to say that rotogravure publication printing is a first cousin to commercial rotogravure, and that, while the technique is in every way similar, the presses used cause a sharp line to be drawn between the two. Publication presses are much larger, and while great consideration is given to quality of reproduction, the emphasis is upon speed and quantity of production.

"I do not mean to say that speed and quantity are not also prime considerations in the commercial field, for the same inherent peculiarity that makes high speeds possible in publishing, also exists in the latter. However, the emphasis is not as great. Primarily, the common factors between the two lie in the ability of gravure inks to dry very quickly, and the nature of the printing process which affords certain advantages in fidelity of reproduction.

"Commercial rotogravure may be divided primarily into two classifications by the method of delivery; roll rewind and sheet delivery. Almost any material can be printed by gravure. However, there are many upon which gravure alone can really achieve quality results. In this last group are cellophane, vinyl films, foil, and glassine. In all cases where these materials can be printed with less quality by other methods, no method can match rotogravure in quantity of production. The limiting factor in production of this type is the cost of the rotogravure printing cylinders, and unless quality is a requisite, production must be confined to fairly large runs. Where quantity requirements are present, rotogravure not only offers higher quality, but also economy.

"On a small press, average production of foil or cellophane is about 26,000 square feet per hour. Glassine averages about 45,000 square feet, and, as a concrete example, one recent installation of a medium size press is producing at speeds up to 600 feet per minute on glassine which provides a quantity of up to 300,000 candy wrappers per hour.

"On paper also, rotogravure is becoming increasingly important, not only for the quantity and quality of production that is available, but also because of the increasing use of roll labels. This is particularly apparent in the tobacco and candy industries. In the bread, frozen food, and generally, the waxed-wrapper field where roll wrappers are mandatory, the advantages, as indicated, are apparent. Current installations also show a large future for the printing of cardboard and decalcomanias.

"In label, brochure and catalogue printing, a rotogravure press, printing from a roll and delivering through a rotary sheeter to a belt or pile delivery, has several interesting operational points. Great productive capacity is gained in rotogravure by the ability to print dry by gravure inks which allow any number of colors to be printed as rapidly as one color, including the so-called difficult inks such as gloss and metallics, and in addition, spot or overprint varnish.

"As a finished gravure job is produced with a single pass of the stock through the press, such conditions as tension, temperature, and humidity are the same for all operations. This eliminates many of the difficulties of register control encountered when time must elapse for ink drying between printing the various colors, as with some other processes.

"Rotogravure is simplified by the elimination of make-ready. Printing starts as soon as the cylinder is in place and the pressure of the doctor blade and impression roller is regulated.

"There is no complicated ink-distribution system, and there is no jumble of rollers to be adjusted or washed. The proper supply of ink is automatic, and the dry print makes slip-sheeting and sprays unnecessary.

"Printing cylinders are not limited to a certain fixed circumference and are free to vary within a wide range between the minimum and maximum sizes. This provides for the economical production of different sizes of work on a single rotogravure press. Although the maximum printing width for each press is determined by its web size, narrower webs, if used, eliminate waste stock.

"An improvement in color register is found, as fast-drying inks permit shorter web leads between printing units. High temperatures for rapid drying, which cause distortions in the web, are not necessary. Shorter web leads and lower temperature drying result in an improved quality of multicolor printing and savings in waste stock.

"With fully enclosed fountains, drying of residual ink in the etched cells is inhibited by the continual flushing of the engraving with fresh ink from the applicator. The continual circulation of the ink prevents the settling of pigments and maintains color consistency throughout the entire run.

"Control of ink volume, an inherent characteristic of gravure, involving carrying ink in a subsurface design, is an important factor in the superiority of this printing, as it provides the opportunity for controlling the volume of ink carried to any given portion of a design. The etch consists of minute cups or recesses which vary in depth as required for the tone which they are to print. This produces a wide range of tonal expression—from the richest depths to the purest high light. The intermediate tones may be produced from up to 15 different depths of etch from the same cylinder.

"The modern gravure press allows quick and convenient removal of the cylinder and tank, as well as easy removal of the inking mechanism. A complete change-over of color and cylinder involves simply removing the cylinder and inking mechanism and replacing with fresh units. The press is then ready to roll, and wash-up can be accomplished on other than press running time. On a continuous job, wash-up for overnight standing is a matter of wiping off a few inches of exposed cylinder. In the morning, the press is ready to roll again after ink flushing.

"Again, as in other usages, as many colors as are required can be printed simultaneously on both sides of the paper. An overall or spot coverage or lacquer, applied in line with the printing by a standard color unit, can eliminate a separate varnishing operation. The printed sheets are delivered completely dry and with no offset, trimmed and cut to a tolerance of $^{1}/_{64}$ inch.

The speed is high, and production at 10 to 16 thousand sheets per hour will exceed the output of comparable letterpress and offset equipment.

"In closing, I should like to quote from instruction material prepared for the rotogravure printing course given by the Technical Trade School, Pressman's Home, Tennessee. 'With the recent developments in press construction, it is now a fact that gravure is by far the fastest and also a serious contender for first place in the modern printing industry, as almost anything can be printed in gravure, such as textiles, silk, wallpaper, oilcloth, labels, box covers, newspaper supplements, foil, catalogs, magazines, books, and cellophane, at a speed up to 30,000 impressions per hour.' "

R. L. Lewis

Empire State

Metropolitan District

The Metropolitan District meeting was held at Fraunces Tavern, New York City on Nov. 14, 1950. The speaker of the evening was Gerard Larocque, Technical Director of the News Syndicate, New York, N. Y. His topic was "Technical Problems of the Newspaper Industry." Mr. Larocque said, in part:

"In spite of the tremendous amount of paper used in the newspaper industry, there are very few technical men employed in it to solve its many problems. The first step in printing the paper is to set the material up in type. This is done on a linotype machine. As the operator types out the words, the lines of print are set up in plates. These are flat plates and cannot be used as such on the high-speed rotating printing presses. The material on these flat plates is, therefore, transferred to curved plates which fit on the rotating presses. Although it takes only 45 minutes from the linotyping of the material to the appearance of the papers on the streets, this is slow compared to the dissemination of news by radio and television.

"The problems in printing a newspaper stem from the fact that a web of paper 5 feet wide and 0.003 of an inch thick is run between two cylinders, one of which has the desired impression, at a speed of 20 miles an hour. For successful operation, the paper must first run through with a minimum of tears or breaks. Secondly, a clear sharp impression must be made on one side without any offset on the other. To do this, a film of ink 0.0003 of an inch thick is laid on the paper. This ink consists of 10 parts mineral oil and 1 part of carbon or soot. This carbon is prepared by using a smoky gas flame and collecting the soot on an iron channel which oscillates against a scraper. Because of this operation, it is called 'Channel Black.'

"The ink must dry instantaneously, preferably by the preferential absorption of the oil into the paper leaving the carbon particles on its surface. This must take place in two fifths of a second, by which time the other side of the paper receives its layer of ink. If the first side is not dry, smudging occurs. This is a common defect called 'offset at second impression.' Magazines eliminate this problem by using more volatile oils as lighter hydrocarbons in their inks. To accelerate the drying of these inks, the freshly printed paper is run over open-gas flames. This was tried out in newspaper printing, but the fire hazard was too great to make it acceptable to management. The magazine printing industry, however, has been able to do it successfully.

"Paper breaks are caused by several factors:

1. The plates are thrown together so quickly that they are not lined up accurately.
2. Rolls are damaged in transit and do not unroll evenly.
3. Many rolls (8 at a time) are printed on a single machine at the same time. If one roll tears, they all stop and it takes 5 to 20 minutes to start over again. One web break may, therefore, mean a loss of 1000 newspapers.

"How to prevent these breaks is the problem of the technical department. On first thought, it seems the solution would be to get a stronger paper. Newspaper publishers would be glad to pay a higher price for a stronger paper if it would eliminate breaks. Unfortunately, there is no correlation between strength of newsprint and number of breaks on the printing press. In fact, it is held that the property of elasticity is more significant in preventing breaks than tensile strength. Yet stretch tests in the laboratory do not forecast actual machine operation because there is a difference in the moisture content of the paper coming out of the roll and the moisture content of the paper in the laboratory. In the final analysis, the best test of a good newsprint is to run it on the presses and observe the results."

Question: Do you condition your paper before printing it?

Answer: No, but we do try to store it in a moist area. The paper should carry as much moisture as possible.

Question: Are there more web breaks in the winter than in the summer?

Answer: Yes, due to the low humidity. Static charges also exert a greater pull on the paper in one way or another and cause more breaks in the winter than in the summer.

Question: What tests do you run to forecast performance on the presses?

Answer: The best test is to print the paper and look at it, and then to keep a record of performance to compare the various mills that supply the newsprint. In general, the paper must be smooth and the formation must be uniform.

Question: Do waterproof seal wraps prevent loss of moisture in the paper?

Answer: Yes. Asphalt-laminated wrapping paper is helpful in preventing drying of the newsprint.

H. M. Annis (Oxford Paper Co.): Tear strength, especially dry tear, and elasticity are important factors in preventing web breaks on the presses. It has been found that drying the paper over a gas flame in letterpress printing causes a loss of 25% in tear strength and may cause a tear in the web. For example, if a paper has a dry tear of less than 18 for a 43-lb. paper, it is likely to give trouble in printing it up. It has also been found that paper made from sulphite pulp from different parts of the country will have different tear and Mullen characteristics and will give different performances on the presses.

M. Steinberg (*New York Times*): Web breaks on the presses depend to a great extent of whether or not the rolls were properly wound. Rolls with soft spots or soft edges will draw unevenly and will result in breaks. Moisture content is also important.

H. M. Annis: There is no doubt but that good winding is very helpful in preventing web breaks.

H. J. Perry (*Paper Trade Journal*): Aging of the rolls would relieve stresses and strains in the paper and would decrease the likelihood of web breaks.

G. Larocque: This would probably be true for an all sulphite paper, but the opposite is true for a groundwood sheet. Groundwood papers lose strength very quickly on standing. Fresh paper will give fewer breaks than paper that is 6 months old. Paper that is 12 months old will give even more breaks.

At this point, the meeting was brought to a close so that all those who wished could visit the *Daily News*' Press Rooms on 42nd Street and witness the actual running off of a complete edition of the paper. This was a specially arranged tour through the courtesy of Dr. Larocque.

William Landes

Western District

The following is a brief summary of the meetings of the Western District of the Empire State Section.

The first meeting on October 4 featured a visit to the River Road plant of E. I. du Pont de Nemours & Co., Inc., in Niagara Falls. Following the dinner meeting Ross Hare, Manager of the plant, gave a short talk describing the various products being manufactured at his plant. J. V. Earle of the Upson Co., Lockport, N. Y., presided as chairman.

The second meeting was held on Wednesday, November 1, at the Prospect House, Niagara Falls, N. Y. This meeting was a joint gathering with the Niagara Branch of the Technical Section of the Canadian Pulp and Paper Association. Approximately one hundred members and guests enjoyed the excellent dinner and program presided over by Irving Earle of the Upson Co., Lockport, N. Y.

Among the guests introduced at the meeting were Henry Perry, Editor of the *Paper Trade Journal* and Chairman of

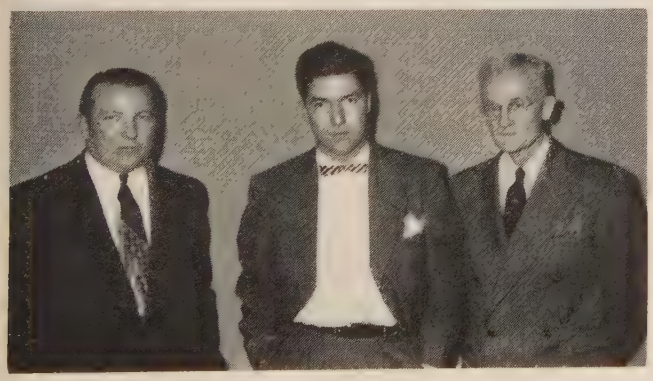
Empire State Section, J. Butterworth, Socony-Vacuum Co., Secretary of the Metropolitan District; Harold Spector, St. Regis Paper Co., Chairman of the Northern District; Ralph Prince, American Cyanamid Co., Secretary-Treasurer, Empire State Section; Homer Rice, DuPont Co., Executive Committeeman, Empire State Section; W. Logan, Secretary, Niagara Branch, C.P.P.A.

Left to right: William Logan, Don Hart, Earnest Vaissiere, Henry Perry, and Irving Earle

Don Hart, Moore Business Forms, introduced the speaker of the evening, E. Vaissiere, Sealright Co., Oswego Falls, N. Y. Mr. Vaissiere, Job Training Supervisor, discussed "A New Approach to Employee Relations." Drawing from his experience, both as an International Union Representative and as a management executive, Mr. Vaissiere gave an inspiring talk tracing the growth of present-day employee-employer relationship.

"Due to present man-power shortage, management today is more aware than ever of the need for promotion of good human relations with labor," Mr. Vaissiere said. The importance of indoctrination methods for improvement of these relations are stressed. "Management today needs to do a selling job to its employees—to sell itself and its products to the worker." Mr. Vaissiere also stated that "the importance of each job must be brought out so that pride in accomplishment and pride in industry can be developed."

The third meeting was held on Wednesday, December 6, at the Prospect House. Approximately 65 members and guests



Left to right: Gordon Starin, Lawrence Egan, and Ross Winship

were present at the dinner. Irving Earle of the Upson Co., Lockport, N. Y., presided at the meeting.

Ross Winship, Moore Business Forms, Niagara Falls, introduced the speaker of the evening, Lawrence W. Egan of Frank W. Egan & Co., Bound Brook, N. J. Mr. Egan discussed "Some Fundamentals of Coating Methods."

"There are ten basic methods of Coating," Mr. Egan said, and gave illustrations of each method. Mr. Egan also stated, "Most paper will be coated on paper machines. Even newsprint will be coated. In prewar years, only the higher priced magazine paper was clay coated. Today, a great many of the lower priced magazines are using coated paper and this trend will continue."

Mr. Egan's talk will not be published since the subject matter of his talk is contained in the new TAPPI Monograph on Coating Machinery now ready at the press and soon to be distributed to members of the Technical Association.

Delaware Valley

Chairman Erspamer welcomed those present and introduced two new members, D. Y. Liversidge of the Eaton-Dikeman Co., Mount Holly Springs, and H. N. Holcombe of the Schmidt and Ault Paper Co., York.

At the request of Program Chairman Haug, who was unable to be present, Mr. Erspamer announced that the St. Joseph's College Paper School was planning to offer a course in the Chemistry of Pulp Handling and Papermaking early in 1951.

The specific topic of the January meeting has not been fully settled but, through the good offices of W. R. Willets, the Program Committee has obtained Glenn Amos, Assistant Executive Secretary, American Paper and Pulp Association, New York, to speak on the subject of the economic aspects of the pulp and paper industry.

R. C. Macdonald, in a letter to Vice-Chairman Haug, asks for the Section's cooperation in channeling routine testing methods to the TAPPI committee collecting these for publication. If possible, each section should contribute at least five or more suitable methods each year to guarantee success of the program. Desirable methods are the quick ones which may be as accurate as the TAPPI standards or adequately accurate to serve a useful purpose in control testing. The audience at the evening's session is urged to contribute methods at the panel discussion which might be included in the compilation.

Chairman Erspamer turned the meeting over to C. M. Connor, Moderator.

Program Chairman Haug had asked the panel members for biographical data but each one was reticent about giving it. However, the members are well known to the section. The panel was: C. M. Connor, W. C. Hamilton & Sons, Miquon, Pa., Kenneth S. Whisler, P. H. Glatfelter Co., Spring Grove, Pa., Ralph E. Green, Thwing-Albert Instrument Co., Philadelphia, Pa., Emil R. Padavic, Container Corp. of America, Philadelphia, Pa., N. V. Edmonson, Scott Paper Co., Chester, Pa., and John T. Ward, Riegel Paper Corp., Milford, N. J.

Mr. Connor stated that the response for requests for questions to be discussed had been overwhelming. There are other indications of great interest in the subject, "Control Testing Methods." Questions which are relevant to those being discussed may, appropriately, be raised from the floor. Also, those having information should offer it. Questions submitted were, in some cases, very large in scope and might well furnish material for an entire evening's discussion.

1. What is the method for estimation of pH of paper by surface spot testing? How sensitive is it? How much reliance may be placed on the test?

Mr. Whisler: The tester must have a good eye for color differences when the indicator is dropping on the surface of the paper. An example is that of using Bromcresol Green indicator solution and then judging the pH by comparing the color developed with the color on the comparator disk. This method is used on both pulps and paper. An eye so trained can determine quite closely from memory without reference to color standards the comparative color of a definite pH value.

Mr. Edmonson: Used on broke. Also good for determining whether alum had been added. With experienced operators will agree to 0.5 pH value.

Mr. Ward: 0.5 is reproducible by this method about the same as with a universal litmus type paper. Not for colored paper.

Mr. Connor: It is most suitable for white papers.

Mr. Liversidge: The accuracy depends on how much it is used. It checks fairly well, even closer than 0.5 pH checks against the extracted pH method.

Mr. Padavic: We use indicator solutions for determining the range of pH for topliner on boxboard. We have not had much success in determining the actual pH of the topliner by this method.

G. K. Boger, Jr. (W. C. Hamilton & Sons): It was used for a time in trying to determine the surface pH of paper. It was found that what was thought to be surface pH agreed closely with the extracted pH and the conclusion reached that it was not suitable for measuring surface pH. Is there a method for determining pH of paper surface?

John P. Weidner (Container Corp. of America): On a sized topliner the indicator is streaked on to check the amount of robbing of acidity of the topliner by the underliner or filler.

2. Describe systems for sulphate pulp testing. What methods are used?

Mr. Ward: We use a ball mill. The pulp is first broken up in a laboratory beater with dull tackle. The determination of the clearing or complete breakup is done by making handsheets, or by checking look-through, or by diluting a sample in a liter graduate. Before addition to the ball mill, the consistency is corrected to 2% air-dry and 100 grams of oven-dried fiber put into the mill. Samples are taken at 60, 120, and 180 furnishes to 200-ml. freeness. Six handsheets are made, at each beating interval, five for physical tests and one for visible inspection. Conditioned at 50% R. H., the samples are tested for burst, tear, and if desired, fold and tensile or any other tests. Values obtained are plotted against beating times. The plotted values are then checked against reference tests, both for the paper grades to be made and the quality of the specific pulp being tested.

Mr. Whisler: We use the Valley beater with the Standard TAPPI Method modified. This yields information on our own pulps so that the production department or others interested can compare lots. This is true for kraft or sulphite.

Mr. Padavic: We do the same on all pulps. We deviate from the TAPPI beating method by beating to two drainage factors. We then rate the pulps—excellent, poor, good, fair, and rejectable.

Mr. Edmonson: We use the Kollergang for uniform testing, run at 4 rev. per gram.

Mr. Connor: Do any of you experience difficulty in formation of acceptable handsheets, especially at the start of a beating test? How is the information used in the mill?

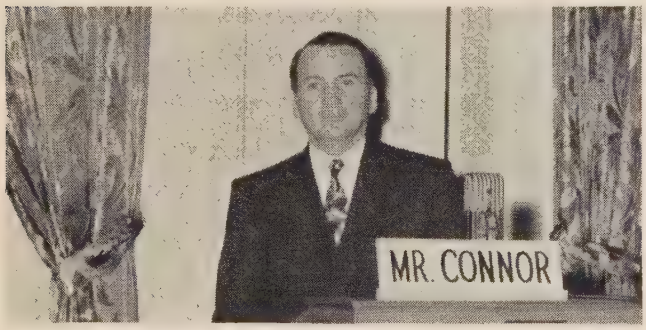
Mr. Edmonson: Results are indications which are followed in the mill.

J. J. Steinbinder (Riegel Paper Corp.): What are the acceptable limits after duplication as a basis for rejection?

Mr. Ward: ± 7% as compared to a standard set of values.

Mr. Padavic: ±10%.

W. D. Rice (P. H. Glatfelter Co.): ±10% but depends on circumstances.



C. M. Connor, moderator of the panel discussion on testing

Mr. Whisler: Handsheet formation is related to the "art of papermaking." One man cannot do it at all, two others are superior to the four or five others who do it for us.

Mr. Connor: What type of mold works best?

Mr. Padavic: The TAPPI standard mold is the one we use and we find it satisfactory.

Mr. Whisler: We use the 5 by 5 inch square sheet mold.

Mr. Ward: The TAPPI Standard sheet mold is more uniform.

Thage Dahlgren (Pioneer Chemical Co.): How does different equipment, such as experimental beaters, affect the results as tackle change factors enter?

Mr. Padavic: We use a standard pulp for rechecking our Valley beater every 6 months. We find that although the beating time increases with time, the strength results do not vary appreciably.

Mr. Erspamer: We had the experience of getting low tests repeatedly. The question arose as to the effect of worn beating tackle. The beater, after sharpening with emery and grinding with sawdust, did not show any appreciable change. We have experimented with the Waring blender and found a fair correlation with laboratory beater on burst tests.

Mr. Dahlgren: A correction is necessary to be rechecked every 6 months or so on account of varied results.

Mr. Padavic: Were you beating to a freeness or a given time?

Mr. Dahlgren: To freeness. With sharp or blunt roll, the results were different and were corrected with a standard pulp.

J. Howard Wright (W. C. Hamilton & Sons): Experience has shown that there was a decided change after wear on the roll... resulted in lower burst and tear...checked every 6 months against a standard bale put away for the purpose. Usually the beater needed to be sharpened and recalibrated.

The panel at the Delaware Valley Section meeting on control testing: John T. Ward, N. V. Edmonson, E. R. Padavic, R. E. Green, and K. S. Whisler

Howard W. Bartlett (Kelco Co.): This was on sulphite, we found it necessary to remove the wire edge formed on grinding or get erroneous freeness values.

Mr. Weidner: Mechanical trouble, such as a bad bearing, roll out of line, stiff diaphragm, is more apt to cause differences.

Mr. Wright: What is your experience in the correlation between permanganate numbers and beating curves? Using a modified permanganate method for kraft pulps where 103 was very soft, 120 hard, 130 very hard (hard enough to result in the blow being held 15 to 20 minutes longer).

Mr. Whisler: Used on our own pulps, we find a correlation.

F. J. Lovegren (W. C. Hamilton & Sons): We have found the same type of correlation in an integrated mill using unbleached sulphite.

Harold C. Brill (E. I. du Pont de Nemours): What accuracy can be expected on tests such as burst, tear, or fold?

Mr. Green: I can answer for one-third of the question. On the Elmendorf tear tester, accuracy will be within 1%.

Mr. Connor: This is closer than the beater test.

Mr. Bartlett: How should a standard pulp be chosen?

Mr. Ward: It doesn't matter as long as the same bale is used for all check testing and reference. The reproducibility should be within the limit of the experimental error.

Mr. Connor: How long can one pulp be held for this use?

Mr. Ward: About 2 years.

3. How can the zero span attachment for tensile testers be used?

Mr. Green: It can be used to measure the maximum utilizable fiber strength. Normal span tensile tests are only some part of the ultimate strength. For example, we found one sheet where the zero span value was 32 pounds and the normal span was 8 pounds, a difference of 400%.

Mr. Connor: For discussion, what is the value of this information?

Mr. Green: It gives a comparison of possible values against those actually produced.

Mr. Connor: How does it relate to the previous question on strength testing?

Mr. Green: It takes very little beating to produce the maximum zero span strength and dropping zero span values indicate a deterioration of the pulp.

Mr. Fisher (Scott Paper Co.): It was used to study the strength properties of fiber at the Institute of Paper Chemistry. We had occasion to run many zero span determinations. It is an interesting fact that with a cotton fiber the tensile strength increases as moisture increases. Likewise, when a plasticizer was added to a sheet, the zero span tensile strength went through a slight increase to a maximum which bound to be statistically significant. It is not known what the clamping effect was but it is believed that the use may be explained as the result of increased fiber strength due to a more even stress distribution due to the presence of the plasticizer. Normal span results fell off 30 to 40% in this same region in which zero span remained at a high level.

Mr. Connor: One full session of the Canadian Technical Section was devoted to this subject in January, 1948, and might be referred to by anyone interested.

Mr. Boger: Coming back to the previous question, what is the correlation between blender test development and that of the hydrapulper?

Mr. Erspamer: Using a 10-gram sample in the Waring blender there are a great many contacts of fiber to blade, whereas in the hydrapulper there is a large volume and small relative number of contacts with the impeller. The amount of time in the hydrapulper would be much longer than in the blender for comparative action. Or in reverse, to get like action to that of the hydrapulper, just touch lightly in the blender.

Mr. Weidner: Wouldn't a plain stirrer give a better correlation?

Mr. Erspamer: Yes, on work with an experimental model of the pulper, the time had to be increased on the large pulper to obtain a similar action.

Mr. Boger: How about slowing down the Waring blender?

Mr. Erspamer: This would give a better correlation just as it would with a stirrer.

Mr. Brill: How close can the normal span be made to come to the zero span?

Mr. Green: One report shows laboratory handsheeting having a normal span tensile strength of 11 pounds, improved by the use of a resin to a normal span strength of 18 pounds, very near 100% agreement between normal and zero span strengths.

4. Is there a good bond test or liner separation test?

Mr. Padavic: We use one similar to that described in the routine TAPPI Test Methods. Dennison testing wax is affixed to each side (at the very edge) of a small sample and then pulled apart and the nature and extent of rupture noted. We are looking for a better method.

Mr. Holcombe: We use the same with Dennison testing waxes.

Mr. Green: There is an anvil attachment for the tensile tester used in conjunction with an adhesive which results in actual measurement of bonding strength in pounds per square inch.

Mr. Weidner: How about the time required? Is it something that would give results for control testing, say in 5 minutes?

Mr. Green: The time depends on the setting time of the adhesive used—the actual testing time being only a matter of seconds.

Mr. Wright: Which adhesive is the best?

Mr. Green: There are about 5000 adhesives, among which there is surely one which will fit special conditions.

Glenn T. Renegar (Container Corp. of America): The adhesive techniques cause differences in results. Pitch is the best and results are obtainable in 20 to 30 minutes. The wax test is quicker and better, but gives a relative value for the portion tested only.

Mr. Green: The last I knew, Fort Orange had been using it as a routine method for some years.

5. Describe a good bending test for board?

Mr. Padavic: For routine control testing of folding boxboard, a diagonal bend (at least 3 inches long) without scoring, on a square foot sample is used. The method affords a margin of safety on bending qualities which is ample, but depends on the judgment of the inspector.

Mr. Green: The National Biscuit Co. measures the spring back on the second bend of a scored board. This characteristic relates to the machine folding of boxes and gives great promise of reducing trouble and loss of production on the automatic machines.

Mr. Padavic: This is not the problem being considered since that test relates only to the forming qualities of the board in their packaging machines.

Mr. Green: The question becomes one of measuring the amount of stretch on a liner. There is lots of agreement on the need for means of checking this but nothing has been done yet.

Mr. Dahlgren: Doesn't the bender depend on the separation of plies?

Mr. Padavic: I don't think so. It depends to a great extent, on the actual fiber to fiber bond, and to some extent, on the strength of the actual fibers.

Mr. Dahlgren: It depends on a separation of plies. There is a tendency for liner stocks to become shorter, if the liner can be split away from the other plies, the board will have a good bender providing the plies will separate. This, in turn, depends on differences of freeness between the various plies.

Mr. Connor: The Howard Smith fold tester has been given a clean bill of health by the Canadian Research Institute.

Mr. Lovegren: Why not use a miniature scoring press?

6. How to test crush resistance of board? (The kind of board for crush not being stated and the questioner not being present, this question was not discussed.)

7. Is the Dennison Wax test best for testing pick? What is the effect of temperature differences, say at 60 to 100°F.

Mr. Whisler: We make no coated paper, so the Dennison waxes meet our needs. As to temperature, pick tests are not run under standard conditions. The results are wanted before the paper gets off the machine so we speed up the test. We do not apply the wax to the sample specimen which is directly backed by a cold surface such as a metal table top. Our testing range is about 70 to 85°F.: 100°F. would probably give a lower pick value.

Mr. Padavic: The method developed by IPI using inks of varying tack on a modified proof press is a good one, particularly, in connection with coatings using a latex adhesive.

Mr. Fisher: At the Institute, the surface packing is tested with a viscous oil on a wheel with variable speed. The rate of shear necessary to rupture the surface is determined. The viscosity and velocities correlate with other sheet properties, such as, burst.

Mr. Brill: The simplest, probably, is the use of electrician's tape applied with finger pressure and then pulled up. The best method is a commercial type press, standardized, with standard inks, and then rates of speed to cause picking are measures of pick strength.

Alfred L. Saindon, Jr. (Curtis Paper Co.): Mill tests may be made with a press but still not give full correlation with the consumer.

Mr. Brill: At the last TAPPI Coating Convention there was a demonstration showing correlation with press speed.

Mr. Connor: What is wrong with the Dennison wax method?

Mr. Padavic: There, too, the Dennison wax test is meaningless when used for checking coatings employing latex type adhesives.

Mr. Connor: Isn't any pick test only a guide to safety?

Mr. Brill: Variations are introduced by pressman, raw material suppliers, and conditions. A sheet giving a 1 or 2 Dennison wax pick actually ran on the press as well as a sheet having a 13 or 14 wax pick. This was coated with polyvinyl alcohol. With rubber latices introduced as a change in adhesives, look out for the Dennison wax results.

8. Is there a test for gloss ink properties of a sheet?

Mr. Bartlett: An instrument called the Vancometer uses mineral oil penetration as a means of measuring this. The curve produced depending on the sheet characteristics correlates through a range from flat to high gloss inks. I am not sure of the figures, but for illustration, a value of 60 to 90 can be used to produce a gloss ink job regardless of the surface, whether paper or board.

Mr. Connor: Very similar to that of Chapman.

Mr. Bartlett: It is almost identical but Mr. Valandingham came out with the Vancometer first. This instrument is an improvement over older techniques of a similar nature.

Mr. Dahlgren: What oil is used?

Mr. Bartlett: A heavy mineral oil is smeared on under controlled conditions and the light reflectance disappearance time is measured. Readings are taken 10 seconds apart after the first 20 seconds. Timing is automatic, the passing of the roller switches on the timer. The time that the gloss disappears defines the possible range of inks suitable. It is manufactured by Hillside Laboratories, Chicago, Ill.

9. Is there a spot control for pitch?

The audience at the Delaware Valley Section discussion on routine control testing

Mr. Edmonson: We use the acetic anhydride method and are looking for a better one.

Mr. Ward: We use quantitative pitch extractions to determine blend pulps for various paper grades. We are looking for a better method. It is the ether extractable portion that gives the trouble not the alcohol fraction. We have supplies of fairly low-pitch content pulps that are blended in furnishes when pitch troubles are most prevalent.

Mr. Bartlett: Attached wire screens run by a Sunbeam mixer

in stock in a laboratory beater results in pickup of pitch which correlates with mill operation. The value beyond which trouble could be expected was found and was more helpful than extraction methods.

Mr. Edmonson: This is similar to the brass plate method.

10. How may the washing efficiency of a pulp washer be tested?

Mr. Ward: The method is described in *Tappi*. Essentially, a series of consistency tests are made on mat and vat stock. Chlorides and active bleach in the stock taken from these two sampling points are titrated with silver nitrate and sodium thiosulphate, respectively. Data obtained are substituted in the following formula:

$$\frac{\frac{\text{Titration before}}{\text{Conc. before}} - \frac{\text{Titration after}}{\text{Conc. after}}}{\frac{\text{Titration before}}{\text{Conc. before}}} \times 100 = \% \text{ Efficiency}$$

A sample of water discharging from the washer leg should be checked for fiber loss and chemical concentration; in case a stream pollution situation is prevalent, a series of water volume meter readings would complete the test.

11. How to determine moisture content? How valid is the sword hygrometer method? What is the best method for testing paper?

Mr. Whisler: We use the Hart moisture meter. We make essentially the same types of paper over a short range of thickness. Eight per cent is maximum on the meter with 2 to 6.5% range generally used. We obtain good results between 3 to 6%. Formerly, we checked the meters weekly but found this wasn't necessary. We conditioned the paper thoroughly, determined the moisture on the Hart meter, and then checked by inserting samples in weighing bottles, drying to constant weight, etc. Checks of ±0.2% between the method were found, regularly. A close check must be made on batteries, tubes, etc. The instrument must be kept clean and the battery models kept at full charged: the battery is important. A sample is taken at the machine in the form of a pad and may be carried some distance if the meter is ready, the protecting sheets are peeled off, the required number of test specimens inserted in the instrument, and the reading made on the dial. Between the 0.5% values read directly: interpolations may be made.

Ellman R. Smith (Union Mill Paper Manufacturing Co.): It is necessary to have the instrument calibrated against specific grade and the basis weights.

Question: How about differences across the sheet in the machine direction even in months old paper? Do you use a pad or a strip?

Mr. Whisler: Averages obtained by inserting various thickness from different places across the machine may be used. Checks may be made very readily by this means.

Question: Wouldn't there be an advantage to an instrument having a roller on the sheet continuously which would measure the moisture content by measuring the static generated, or an attachment on a static suppressor?

12. What methods may be used to measure dimensional stability?

Group at the Nov. 17th meeting of the New England Section of TAPPI

Mr. Green: There is the Neenah expansimeter developed in conjunction with the Paper Institute, one developed by the National Bureau of Standards, and one developed by Mr. Geohegan and associates. The first two measure the total expansion or contraction after equilibrium is established at high or low relative humidity atmospheres. The newest measures the rate going from 50% R. H. to 80% R. H. or from 80% to 50% R. H.

Mr. Wright: How much time is required to condition the sheet?

Mr. Green: I do not know about conditioning time, but results are obtained in 10 minutes after the conditioning.

Mr. Wright: There is an immersion method which shows some correlation with the amount of expansion difference in specified relative humidity changes.

13. How significant and how practical is the statistical approach to control testing in the paper fields?

Mr. Connor: Perhaps, the next panel will discuss this subject when we can devote the whole evening to it.

Mr. Connor thanked his panel and the audience and turned the meeting back to Mr. Erspamer after 10:00 p.m. Chairman Erspamer expressed the thanks of the section to Mr. Connor and the panel before adjourning the meeting.

EMIL R. PADAVIC

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NATIONAL

Annual Meeting, Commodore Hotel, New York, N. Y., February 19–22, 1951.

Second Coating Conference, Statler Hotel, Boston, Mass., April 18–20, 1951
- General Chairman—J. H. Heuer, St. Regis Paper Co., Deferiet, N. Y.
- Program Chairman—Alfred D. Bonanno, Champion-International Co., Lawrence, Mass.

Sixth Engineering Conference of the Pulp and Paper Industry, General Oglethorpe Hotel, Wilmington Island, Savannah, Ga., October 15–18, 1951
- General Chairman—George H. Pringle, Mead Corp., Chillicothe, Ohio
- Local Arrangements Chairman—James R. Lientz, Union Bag & Paper Co., Savannah, Ga.

LOCAL SECTIONS

Ohio Section:
- February 8, 1951, Hotel Sheraton Arms, Cincinnati, Ohio.
- March 8, 1951, Manchester Hotel, Middletown, Ohio.
- April 10, 1951, Manchester Hotel, Middletown, Ohio.

Pacific Section:
- February 6, 1951, Olympia, Wash.
- April 13, 1951, Longview, Wash.

New England Section:
- January 19, 1951, Roger Smith Hotel, Holyoke, Mass.

Lake Erie Papermakers and Converters:
- January 19, 1951, Hickory Grill, Cleveland, Ohio.
- February 16, 1951, Hickory Grill, Cleveland, Ohio.

Delaware Valley Section:
- January 25, 1951, Engineers Club, Philadelphia, Pa.
- March 22, 1951, Engineers Club, Philadelphia, Pa.
- April 26, 1951, Engineers Club, Philadelphia, Pa.

Chicago Section:
- January 15, 1951, Chicago Bar Association, Chicago, Ill.

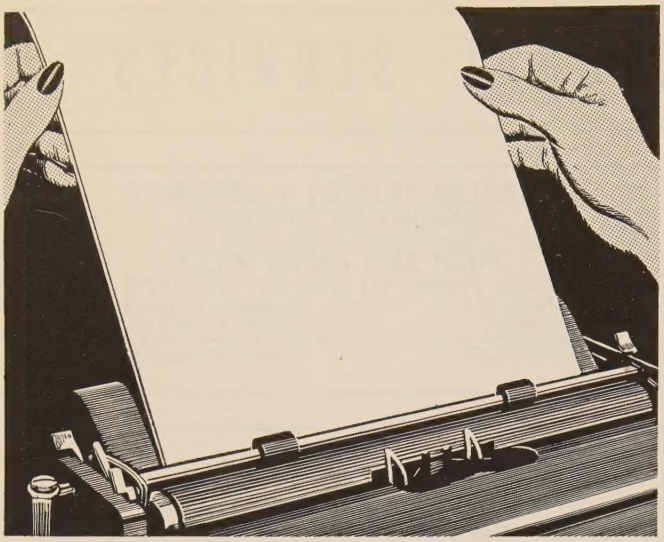
Kalamazoo Valley Section:
- January 18, 1951, Park American Hotel, Kalamazoo, Mich.

Metropolitan Group, Empire State Section:
- March 6, 1951, Fraunces Tavern, New York, N. Y.
- April 3, 1951, Fraunces Tavern, New York, N. Y.

Northern Group, Empire State Section:
- February 8, 1951, Woodruff Hotel, Watertown, N. Y.
- March 8, 1951, Woodruff Hotel, Watertown, N. Y.
- April 12, 1951, Woodruff Hotel, Watertown, N. Y.
- May 10, 1951, Woodruff Hotel, Watertown, N. Y.

Eastern Group, Empire State Section:
- January 18, 1951, Milfranks Restaurant, South Glens Falls, N. Y.
- February 16, 1951, Milfranks Restaurant, South Glens Falls, N. Y.

Lake States Section:
- March 13, 1951, Stevens Point, Wis.



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INDEX TO ADVERTISERS

Allis Co., Louis	29 A
American Polymer Corp.	63 A
Appleton Machine Co.	51 A
Appleton Wire Works, Inc.	34 A
Armstrong Machine Works	25 A
Babcock & Wilcox Co.	17 A
Bauer Bros. Co.	61 A
Beloit Iron Works	1 A
Bird Machine Company	47 A
Black-Clawson (Shartle & Dilts)	4 A
Brown Co.	7 A
Buffalo Electro-Chemical Co.	3 A
Butterworth & Sons Co., H. W.	92 A
Chicago Bridge & Iron Co.	36 A
Cleary Corp., W. A.	55 A
Combustion Engineering-Superheater, Inc.	6 A
Curlator Corp.	4th Cover
Dicalite Div. (Great Lakes Carbon Corp.)	59 A
Dorr Co., The	42 A
Dow Chemical Co., The	23 A
Draper Brothers Co.	65 A
Drupa International Exposition	64 A
Farrel-Birmingham Co., Inc.	13 A
Geigy Co. (Dyestuff Div.)	62 A
Goodyear Tire & Rubber Co.	15 A
Gottesman & Co.	38 A
Gurley, W. & L. E.	60 A
Hauser-Stander Tank Co.	44 A
Hercules Powder Co.	2nd Cover
Hermann Manufacturing Co.	49 A
Huber Corp., J. M.	41 A
Infilco, Inc.	27 A
Johns-Manville Corp.	39 A
Jones & Sons Co., E. D.	40 A
Kelco Co.	57 A
Lodding Engineering Co., Inc.	8 A
Mallinckrodt Chemical Works	60 A
National Aniline Division	43 A
National Forge & Ordnance Co.	64 A
Niagara Alkali Co.	3rd Cover
NOPCO Chemical Co.	37 A
Philadelphia Quartz Co.	16 A
Prior Chemical Corp.	66 A
Pusey & Jones Corp.	21 A
Rohm & Haas Co.	35 A
Sandy Hill Iron & Brass Works	53 A
Solvay Sales Div. (Allied Chem. & Dye Corp.)	9 A
Soundview Pulp Co.	20 A
Stebbins Engineering & Mfg. Co.	32 A
Testing Machines Inc.	67 A
Torrington Co.	31 A
Vanderbilt Co., R. T.	11 A
Wallace & Tiernan Co., Inc.	33 A
Wallerstein Co.	62 A
Westinghouse Electric Corp.	18 A–19 A

PROFESSIONAL SERVICES

American Defribrator, Inc.	91 A
Bjorksten Research Laboratories	91 A
Knowles Associates	91 A
Chas. T. Main, Inc.	91 A
Myers & Addington	91 A
Roderick O'Donoghue	91 A
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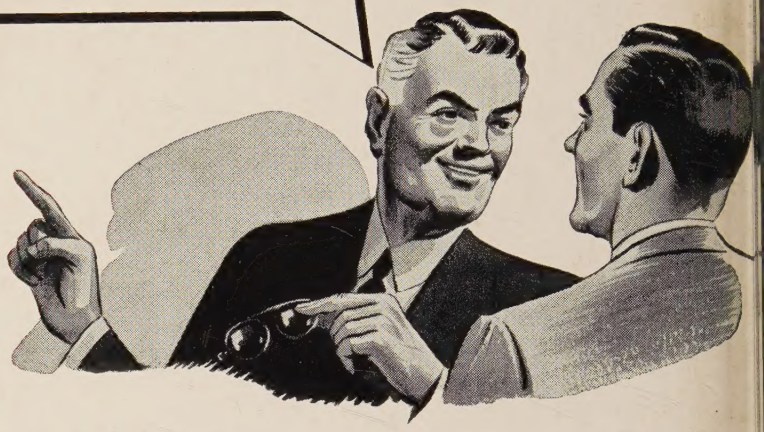

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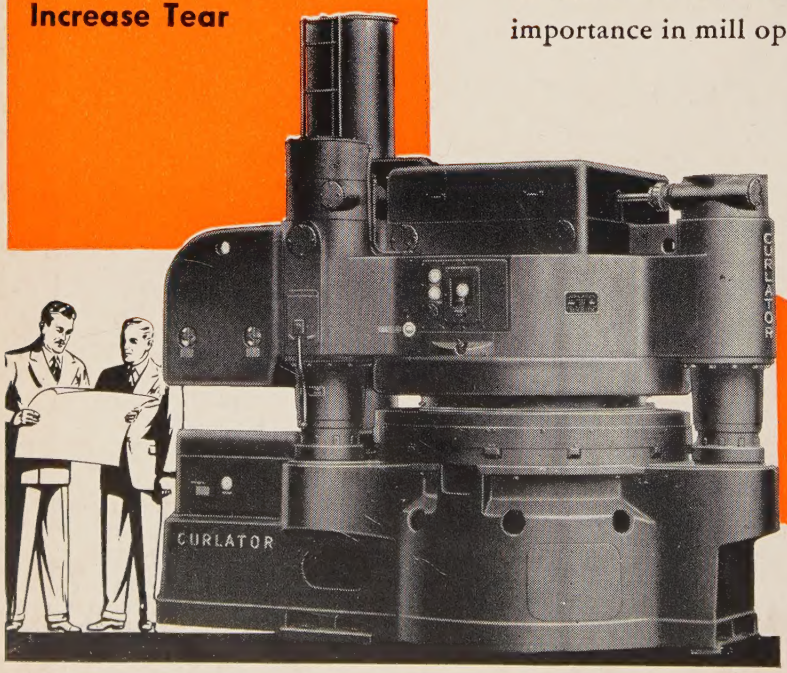

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